Addressing literacy skills in kindergartners in Alaska: An evaluation of *Lexia Reading Core5*®

By

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Abstract

The purpose of this study was to evaluate *Core5,* a computer-assisted instruction (CAI) programme*,* on developing early literacy skills in struggling kindergartners and providing enrichment for high achieving kindergartners. Conducted through the positivist research paradigm, the research design of this study is a quantitative quasi-experimental non-equivalent control group pretest-posttest design using the probes AIMSweb Letter Name Fluency (LNF), AIMSweb Letter Sound Fluency (LSF), MAP K-2 Early Literacy, as well as a questionnaire regarding teacher perceptions of *Core5* and its implementation in the classroom. This study used convenience sampling instead of probability sampling since many schools already use *Core5.* Fifteen schools in the Matanuska Susitna Borough School District was the target population. The sample group comprised of 751 kindergartners, aged five to six-year-olds divided into the treatment group, the partial treatment group, and the control group. Posttest analysis of LNF and LSF data confirmed all three groups made gains from the pretest, but an ANOVA indicated there was a significant difference between the three groups. A Bonferroni post hoc test determined the treatment group and the partial treatment group were significantly different from the control group. The posttest analysis of MAP K-2 Early Literacy data indicated that all three groups made gains from the pretest. An ANOVA suggested there was no significant difference between the three groups. Lastly, the end-of-year *Core5* levels were correlated to the benchmark scores on LNF, LSF and MAP K-2 Early Literacy probes using Pearson's *r.* The teacher questionnaire indicated that a majority of teachers have a favourable view of *Core5,* which is vital to the implementation of *Core5* because their attitude is also a significant predictor of student use in the classroom. The findings indicate that *Core5* is an effective CAI program to use as part of the kindergarten ELA curriculum. The findings also add to the volume of research on *Core5,* CAI programmes and blended learning.

Key Terms: blended learning, CAI programmes, early literacy development, reading intervention

Declaration

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Addressing literacy skills in kindergartners in Alaska: An evaluation of *Lexia Reading Core5*®

I declare that I wrote this thesis and did all the work related to the thesis. I cited the sources used, ethically compiled the data, and ran the statistical tests to find the results.

I further declare that I have not previously submitted any part of this work for any other qualification.

Joy Owens 01/21/2020

Signature and date

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Abbreviations and Acronyms

ANOVA	Analysis of Variance
CAI	Computer-assisted instruction
CBM	Curriculum-Based Measurement
Core5	*Lexia Reading Core5*®
DEED	Department of education and early development
EGRA	Early Grade Reading Assessment
ELA	English Language Acquisition
ELL	English Language Learner
GRADE	Group Reading Assessment and Diagnostic Evaluation
IEP	Individualised Education Programme
LNF	Letter Name Fluency
LSF	Letter Sound Fluency
MSBSD	Matanuska Susitna Borough School District
NAEP	National Assessment of Educational Progress
NWEA	Northwest Evaluation Association
ORF	Oral Reading Fluency
RIT	Rasch Unit
SOS	Lexia strategies for Older students
SPSS	Statistical Package for Social Sciences
ZPD	Zone of Proximal Development

1 Chapter 1: Introduction to the study

1.1 The Background

Student success in school is directly related to their ability to read. Not only do students utilise reading skills for school, but reading skills are also necessary to be successful in life. Poor reading skills can have a domino effect on one's life since "difficulties in learning to read can have serious adverse consequences" (Hulme & Snowling, 2013, pg. 1). The adverse consequences of poor reading can cause economic and social disadvantages later in life.

Struggling readers are in every part of the world, even in developed countries that tout education as a priority. The issue of students struggling with reading is especially prevalent in Alaska. The National Assessment of Educational Progress (NAEP) deems the 40th percentile and higher as proficiency. According to the NAEP 2017 comparison, 64% of fourth-grade students nationwide were below proficiency compared to 72% of Alaskan fourth graders (DEED, 2017). According to the 2017 Alaska statewide assessment, 66% of third-graders were below proficiency (20-39 percentile) or far below proficiency (0-19 percentile) in English Language Arts (DEED, 2018). While it is alarming that third and fourth-grade students are performing at such a low level, the focus should be on early literacy skills taught in kindergarten that enable students to become strong readers in the first and second grades. Students who leave kindergarten without the decoding skills of knowing letter names and letter sounds fluently are at risk of falling behind in the first grade. Research shows that students who struggle to read during K-3rd grade will continue to struggle to read for the rest of their education (DuBois, Volpe, & Hemphill, 2014) and "a student who cannot read on grade level by 3rd grade is four times less likely to graduate by age 19 than a child who does read proficiently" (Sparks, 2011, para3).

The Matanuska Susitna Borough School District (MSBSD) located in Alaska, reported that 50% of kindergartners started the 2017-2018 school year with no or with low letter name knowledge (MSBSD, 2018). For many classrooms

around MSBSD, approximately 50% of the kindergarten population were in strategic or intensive early literacy interventions. The scores from the past four years reveal a downward trend in the percentage of students starting kindergarten with letter name and sound knowledge. As seen in Table 1 below, in the fall of 2014, only 24% of kindergartners did not know their letter names, while in fall of 2017, the number increased to 33.6% who did not know their letter names. The percentage of kindergartners who do not know their letter sounds is always higher than those who do not know their letter names. However, there was a similar increasing trend in the percentage of students who did not know letter sounds at the beginning of the school year between fall 2014 to fall 2017.

Table 1.1: MSBSD Kindergarten Letter Name Fluency and Letter Sound Fluency Longitudinal data

The percentage of students who do not know letter names and letter sounds (MSBSD, 2018)

AIMSweb	Percentage of Tier 3 Students											
Measure	F14	W14	S15	F15	W15	S16	F16	W16	S17	F17	W17	S18
K: LNF	24.3%	21.6%	19.1%	29.5%	28.6%	25.6%	28.0%	28.0%	23.0%	33.6%	22.8%	20.3%
K: LSF	44.0%	22.6%	16.4%	48.6%	32.3%	19.1%	47.0%	29.0%	19.0%	52.6%	22.8%	15.3%

(Fall, Winter and Spring data from 2014 to 2018.)

Kindergarten curriculum provides comprehensive literacy instruction that targets early literacy skills. However, when students start kindergarten with impoverished early literacy skills, they need intensive support, or they will struggle to reach benchmark goals (Kaminski, Abbott, Bravo Aguayo, Latimer, & Good, 2014). Thus, it is imperative to prevent poor reading skills by developing early literacy skills such as print awareness, letter knowledge (recognising and naming letters), and phonological awareness (sounds in a word, rhyming, blending), along with vocabulary and oral comprehension.

Schools need to offer substantial reading interventions to provide systematic learning for struggling students (Boulay et al., 2015). However, like DuBois, Volpe, and Hemphill (2014) point out, many schools have limited resources for the large number of students with deficiencies in early literacy skills. Thus, any support instituted to prevent reading failure should be user-friendly and practical. Schools implement blended learning to support struggling students and

to provide an easy way for teachers to differentiate their instruction. Blending learning utilises computer-assisted instruction (CAI) programmes which are usually cheaper for schools than hiring tutors, and students usually enjoy the interactive activities and games the programmes implement to teach concepts. The positive feedback, games, individualised instruction, and graphic displays are the reasons students may find CAI to be motivating (Saine et al., 2011). Since CAI also allows students to work at their own pace, they can practise as many times as necessary to master the content. This independent practice would probably not be possible in a traditional classroom setting (Johnson, Perry, & Shamir, 2010).

1.2 The Research Problem

To address the large number of kindergartners needing support, several schools in MSBSD incorporated *Lexia Reading Core5® (Core5)*, a CAI programme, as part of the kindergarten curriculum in the 2016-2017 school year. Research provided by Lexia Learning Company touting significant reading gains for its users influenced this decision by schools to use *Core5*. A look at the data (Table 2) shows that the scores improved slightly across the district since the implementation of *Core5*. The percentage of kindergartners who did not know the benchmark number of letter names fell from 28% in fall 2016 to 23% in spring 2017. The decrease became more pronounced between fall 2017 and spring 2018: from 33.6% to 20.3%. The percentage of students not meeting the letter sound benchmark fell from 52.6% in fall 2017 to only 15.3% in spring 2018; a 37% difference.

Table 1.2: MSBSD Kindergarten Letter Name Fluency and Letter Sound Fluency Tier 3 Data (MSBSD, 2018)

District data showed pronounced gains after Core5 implementation.

AIMSweb Measure	Percentage of Tier 3 Students											
	F14	W14	S15	F15	W15	S16	F16	W16	S17	F17	W17	S18
K: LNF	24.3%	21.6%	19.1%	29.5%	28.6%	25.6%	28.0%	28.0%	23.0%	33.6%	22.8%	20.3%
K: LSF	44.0%	22.6%	16.4%	48.6%	32.3%	19.1%	47.0%	29.0%	19.0%	52.6%	22.8%	15.3%

(Fall, Winter and Spring data from 2014 to 2018.)

The question then arises: does using *Core5* as part of the kindergarten curriculum significantly improve kindergarten literacy skills? If there is no significant improvement, then the money spent on *Core5* licenses could be better applied elsewhere. Recent studies on *Core5* indicate that it is an effective tool in enhancing literacy skills (Schechter et al., 2015; Wilkes et al., 2016). However, this research was paid for by Lexia Learning Systems and performed by researchers employed by the company. Only one independent study has been conducted (O'Callaghan, McIvor, McVeigh, & Rushe, 2016). Also, Ness, Couperus, & Willey (2013) did not find *Lexia Reading*, an older version of *Core5,* to significantly improve literacy skills.

Core5 research examined its effectiveness on low socio-economic primary school age students, on English Language Learner (ELL) students, and as part of a blended learning programme (O'Callaghan et al., 2016; Prescott, Bundschuh, Kazakoff, & Macaruso, 2018; Schechter et al., 2017; Schechter et al., 2015; Wilkes et al., 2016). Research on using *Core5* as blended learning has varied from teacher engagement (Schechter et al., 2017) to differentiating instruction for reader profiles (Baron et al., 2019) to blended learning and ELL students (Kazakoff, Macaruso, & Hook, 2018).

Schechter, Macaruso, Kazakoff, and Brooke's (2015) study of low socioeconomic first and second graders determined that the treatment group made more significant gains in reading comprehension and vocabulary than the control group. When analysed the effect size of *Core5* on reading comprehension was 0.75, which falls into the moderate-to-high range. However, a later study by Kazakoff, Macaruso, and Hook (2018) found no difference in gains between ELL students and non-ELL students using *Core5*.

O'Callaghan, McIvor, McVeigh, and Rushe's (2016) study is the only independent research on *Core5*. The study was conducted in England and Wales, and the results demonstrated that *Core5* was an effective intervention for boosting phonological skills for students aged 4-6. However, the researchers noted that 35% of the treatment participants failed to make any progress in blending

(combining the sounds in a word) and segmenting (separating the sounds in a word).

While the above studies found *Core5* to be effective, Ness, Couperus, & Willey (2013) did not. They evaluated *Lexia Reading* (early *Core5* version) in New Zealand with 37 students in grades 1-5 who were at risk in terms of reading skills. This study found no statistically significant difference between the treatment and control group at posttest in the areas of word reading, spelling, and reading comprehension.

There is a need for independent research regarding *Core5* that is not sponsored or performed by entities with a personal connection to the product. This personal connection could affect the professional judgement of the researchers (Kahn & Goodell, 2009). While disclosing the potential conflicts of interest allows the reader to examine the research critically, it does not necessarily prevent the researcher's bias from influencing the research or its conclusions.

This current study adds to the independent research on *Core5* and provides clear evidence for MSBSD regarding the effect of *Core5* improving early literacy skills such as decoding and language comprehension. The evidence from this study could determine the implementation of *Core5* in schools across the district.

1.3 The Purpose of the Study

The purpose of this study was to evaluate *Core5,* when used as part of the kindergarten English Language Acquisition (ELA) curriculum, on developing early literacy skills in struggling kindergartners and providing enrichment for high achieving kindergartners. *Core5* supports literacy skills with activities in phonological awareness, phonics, fluency, vocabulary, and comprehension. Thus, it can be included as part of the ELA kindergarten curriculum as both an intervention tool and an enrichment tool allowing students to progress through kindergarten skills and on to first-grade skills. With budget cuts looming across numerous school districts in Alaska and across the United States, many schools

are turning to computer programmes like *Core5* to address the skill deficiencies of struggling students. Having independent research examining *Core5* allows educators to make an informed, unbiased decision on whether to incorporate the programme as part of the school curriculum. Additionally, this study extended the current research by examining the perceptions teachers have of *Core5*.

This study was conducted through the positivist research paradigm, and the epistemology of this design was that reality could be measured (Aliyu et al., 2014). The primary research questions examined the *Core5* programme's effectiveness in supporting the decoding skills and oral language comprehension skills, the two components of the *simple view of reading* theory. The secondary research questions examined the correlation between end-of-year *Core5* levels and benchmark scores, and the perceptions teachers have of *Core5*.

1.4 Research Questions

This study aimed to evaluate *Lexia Reading Core5*® on kindergarten early literacy development. Two primary research questions and two secondary research questions were addressed in this study.

The following are the primary research questions and the associated null and alternative hypotheses.

RQ_1. Is there a statistically significant difference in the decoding skills (letter name of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

$H_{1,0}$. There is no statistically significant difference in the decoding skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

$H_{1,A}$. There is a statistically significant difference in the decoding skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

RQ_2. Is there a statistically significant difference in the vocabulary and comprehension skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

$H_{2,0}$. There is no statistically significant difference in the vocabulary and comprehension of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

$H_{2,A}$. There is a statistically significant difference in the vocabulary and comprehension of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

The secondary research questions are:

RQ_3. What is the correlation between completing all kindergarten *Lexia Reading Core5*® levels and meeting end-of-year benchmarks?

RQ_4. What perceptions do teachers have regarding *Lexia Reading Core5*®?

1.5 Research Objectives

This study aimed to evaluate *Core5* on the development of early literacy skills in kindergartners.

The first objective of the study was to:

- Determine the impact *Core5* usage had on the development of decoding skills in kindergartners.

To achieve this objective, the data from *Core5* and the pretest-posttest data from the assessments AIMSweb Letter Name Fluency and AIMSweb Letter Sound Fluency were analysed for growth and significant statistical difference.

The second objective of the study was to:

- Determine the impact *Core5* usage had on the development of vocabulary and comprehension skills in kindergartners.

To achieve this objective, the data from *Core5* and the pretest-posttest data from the MAP K-2 Early Literacy assessment were analysed for growth and significant statistical difference.

The third objective of the study was to:

- Determine the correlation between *Core5* levels and the end-of-year benchmarks on the three assessments.

To achieve this objective, the improvements the kindergartners made on the *Core5* levels were compiled and compared to their end-of-year scores on the three assessments.

1.6 Theoretical Framework

Theories explain and understand all aspects of life. They are also used to challenge generally accepted ideas or knowledge. Researchers use theories as guidelines when developing a perspective on a research topic. Research topics are viewed through different theories, and each theory influences the approach researchers take when conducting a study (Kumar, 2012).

Different theories regarding learning fall under two main approaches: the behavioural approach and the constructivist approach. The behavioural approach to learning focuses on external events such as the effect of the teacher or

classroom environment on the development of students (Hassad, 2011). Learning occurs when the stimulus provided creates a particular response, and each subsequent stimulus strengthens or weakens that particular response. In this type of approach, instruction is direct and teacher-centred. Students are not self-motivated but motivated extrinsically through rewards or punishment.

Skinner and Watson, two theorists of the behaviouralist approach and sought to demonstrate how learning could be predicted and controlled (Weegar & Pacis, 2012). They studied the impact of the environment on the behaviour in learning habits. They examined the effect of the behavioralist approach on learning and determined that given the right environment everyone would learn identically.

Behaviourism is as a critical component in many educational, technological programmes. Skinner created a teaching machine in 1958, where the individual instruction occurred through rote-and-drill (memorising and repeating) (Weegar & Pacis, 2012). Today, many educational software programmes reinforce different learning skills through rote-and-drill. Students must accurately accomplish small steps before moving on to more difficult tasks.

Constructivists believe learning occurs when students are participating in their learning or actively searching for meaning (Weegar & Pacis, 2012). According to this approach, children develop knowledge when they engage in the learning process. Learning occurs when the learner constructs his/her knowledge and thus develops his/her understanding through the learning experience (Weegar & Pacis, 2012). In this approach, instruction is usually student-directed and student-centred. Students are self-motivated to learn as they are active participants in the learning process.

The two leading developers of constructivism are Jean Piaget and Lev Vygotsky. They both believed that children develop knowledge through participating in the learning process. However, Piaget believed “cognitive development was a product of the mind achieved through observation and experimentation whereas Vygotsky viewed it as a social process, achieved

through interaction with more knowledgeable members of the culture" (Rummel, 2008 as cited in Weegar & Pacis, 2012, pg. 6). In Piaget's theory, learners construct their knowledge through personal experiences to understand and implement the information they have acquired. Vygotsky believed the social environment was crucial to learning.

Constructivism supports multiple teaching approaches and strategies (Hassad, 2011). The teacher is the guide or facilitator in creating activities that encourage active engagement, problem-solving and team-building or collaboration. According to White-Clark et al., (2008), "Cooperative learning, hands-on activities, discovery learning, differentiated instruction, technology, distributed practice, critical thinking, and manipulatives are elements that embrace the constructivist educational philosophy" (pg. 41).

Blended learning is based on the principles of the constructivist approach of student-directed learning because students use technology to learn at their own pace. The instruction is differentiated, and teachers focus on missing skills gaps with individual students. However, CAI programmes implemented in a blended learning environment often follow the behaviouralist approach with activities using rote-and-drill to help solidify practised skills.

Many educators use aspects of behaviouralist and constructivist approaches in their classroom. They implement student-led activities but also include direct-instruction when needed. This is especially true in the kindergarten classroom. Many times, kindergartners are taught letter-sounds and letter-names through direct instruction but then have a hands-on activity where the kindergartners use different mediums to create the letters they just learned.

Just as many educators incorporate both approaches, this study relied on two theories stemming from the behaviouralist and the constructivist approaches. First, this study built on the constructivist ideas put forth in the Zone of Proximal Development (ZPD) concept of Vygotsky's sociocultural theory to support blended learning in the classroom and determine how *Core5* supports student development in early literacy skills. Second, the study built on the *simple view of reading (SVR)*

theory to support the use of decoding and oral comprehension (skills explicitly taught in *Core5*) as the foundation of reading. While SVR is a theory on how reading develops, it would fall under the behaviouralist approach as it subscribes to direct instruction of decoding and comprehension skills.

1.6.1 The Zone of Proximal Development

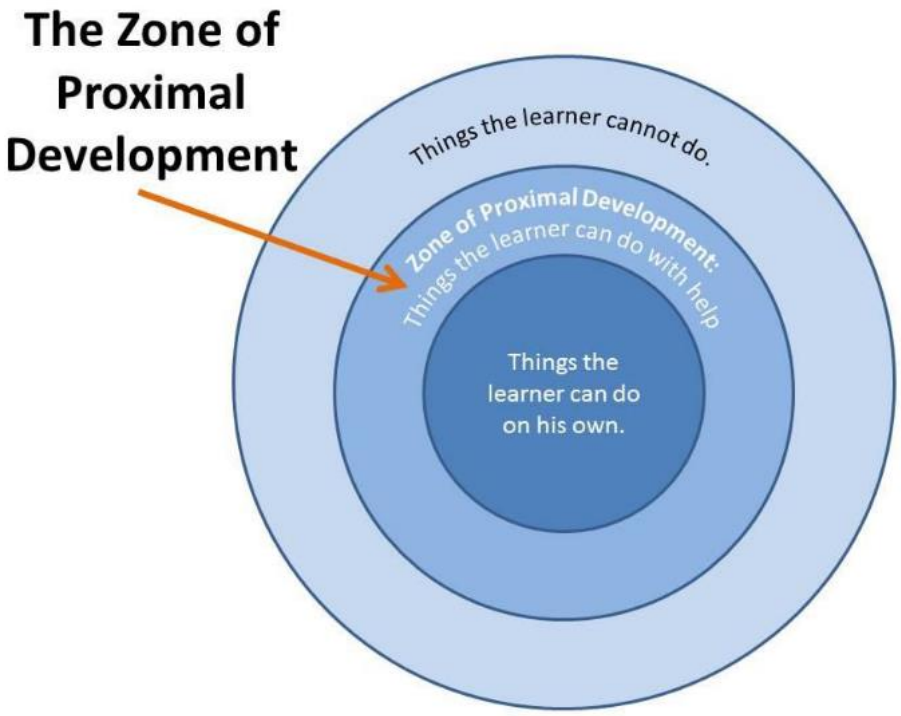
Lev Vygotsky, a Russian psychologist who significantly influenced constructivism, developed the Zone of Proximal Development concept (ZPD). In the definition by Vygotsky, ZPD is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

Eun (2019) cites three ways to interpret this definition. First, ZPD is the distance between a learner being able to perform a task with help versus without help. In this idea, instruction is scaffolded by the teacher until the learner can perform independently. This definition is the one used within the educational realm. Second, ZPD is the distance between understood knowledge and active knowledge. In other words, understood knowledge is developed through instruction and applied knowledge is developed by the learner's interactions with the world or their personal experiences. Third, ZPD is the distance between individual and social activities (Eun, 2019). This definition focuses on how society changes based on individuals engaging in collaboration to create new social norms.

Using the first interpretation of this definition, ZPD is the difference between the space that represents internalised knowledge and skills, and the space where problem-solving skills and knowledge are developed through guidance (Lavin & Nakano, 2017). ZPD focuses on what the student can do at the beginning of the learning stage on their own, what they can do with assistance (the proximal stage), and what is currently beyond their abilities to do. An effective teacher or curriculum

will focus on learning that is just slightly beyond a student's abilities and focus on what student can accomplish with assistance. Figure 1.1 depicts the educational interpretation of ZPD.

Figure 1.1: The Zone of Proximal Development diagram (Lavin & Nakano, 2017).



One key component of the educational interpretation of ZPD is the use of scaffolding. The term *proximal* in ZPD refers to the assistance provided to help a learner to go beyond their current competence and build on their current abilities (Shabani, Khatib, & Ebadi, 2010), and scaffolding is the process of modelling and assisting learners until they can do the tasks on their own (Kim et al., 2010). Support and guidance come in many forms such as demonstrating how to accomplish a task, providing specific instructions, providing encouragement and helping the learner think through their problems. In a classroom, both the teacher and students who have mastered the task can provide scaffolded support. As the student internalises the instruction and can complete the tasks without assistance, the support is gradually withdrawn (Kim et al., 2010).

Using this theory, any instructional programme or curriculum should focus on learning in the proximal zone. In a classroom with varying skills, it can be hard to provide instruction to every student in their proximal zone. Often, instruction is directed at the middle performing students. The higher-performing students suffer from boredom because they are not learning new skills and the lower-performing students are unable to keep pace with the instruction. Thus, teachers need to be able to differentiate their instruction because developmentally inappropriate instruction can lead to development regression instead of progression (Eun, 2019).

Blended learning builds on the idea of scaffolding instruction and providing differentiation to all students. CAI programmes allow students to work in their proximal zone and move forward in their development. Students can work independently on the programme's activities. *Core5* builds on the theory of ZPD by assessing students' reading skills and placing them at the level of learning that matches their abilities. *Core5* also provides scaffolded instruction when a student struggles. Thus, ZPD is one of the theories used in the theoretical framework of this study.

1.6.2 The Simple View of Reading Theory

In 1997, the United States Congress created the National Reading Panel to find the best ways to teach children to read. In 2000, the National Reading Panel report identified five reading skills needed to be taught for students to become proficient readers: phonemic awareness, phonics, fluency, vocabulary, and text comprehension (Child Development, 2019). If a student struggles with these five skills, they will struggle to read. Thus, early literacy curriculum needs to address all five skills, and teachers should be knowledgeable in effective reading skills instruction.

Reading skills can be broken into two categories: decoding and comprehension. Phonemic awareness, phonics and fluency influence a reader's decoding ability. Phonemic awareness is the ability to identify phonemes or

individual sounds in a word. For example, the ability to identify the sound /f/, in *fish*, is phonemic awareness. Phonics is the relationship between the sound and their spellings. For example, the ability to recognise the letter *f* in *fish* and know it signifies the sound /f/. Without phonemic awareness and phonics, students cannot decode words. Fluency in early reading skills is how fast students can accurately decode or recognise letters and their corresponding sounds. If a student reads too slowly, their comprehension is impacted. Vocabulary and linguistic comprehension determine a student's reading comprehension. Students need to know what the words they are reading or hearing represent. If a student does not understand 98% of the vocabulary in the text, their comprehension of the text will be impeded (Nation & Beglar, 2007; Schmitt, Jiang & Grabe, 2011). Lastly, students need to have the strategies necessary to process the text and understand its meaning.

The *simple view of reading* (SVR) theory initially put forth by Gough and Tunmer (1986) states that reading comprehension (RC) is a product of one's linguistic (oral) comprehension (LC) and decoding (D) skills. In SVR, decoding and oral comprehension skills are necessary to develop reading comprehension skills (Gough & Tunmer, 1986; Massonnié, Bianco, Lima, & Bressoux, 2019; Savage et al., 2015).

The SVR is a theory to explain the complex process of reading: recognising letters, knowing the corresponding sounds and processing them together to create meaning. Linguistic comprehension includes discourse, vocabulary and background knowledge while the decoding term includes decoding alphabetic print to derive word pronunciations and sight word recognition (Kirby & Savage, 2008; Massonnie et al., 2019). To explain the relationship between decoding, linguistic comprehension, and reading comprehension, Gough and Tunmer (1986) created an equation. The equation used to describe this framework is RC=LC x D. Hoover and Gough (1990) supported the idea that RC = LC x D as opposed to the additive model of RC = D + LC. Their research demonstrated the predictive value of the productive model and found that the additive model can be informative but does

not provide an adequate description of the decoding and linguistic comprehension relationship to reading comprehension. Kieffer and Vukovic's (2012) research confirmed that the product (D x LC) model worked better than the additive model. They also suggested that either formula demonstrates that decoding and linguistic comprehension affects reading comprehension. An example of the RC= D x LC is evident in readers who have dyslexia (a decoding disability) but good linguistic comprehension, or those who have hyperlexia (weak linguistic comprehension) but excellent decoding skills. In either case, the student would struggle with reading comprehension.

Some researchers feel SVR is too reductionist or straightforward to be used as an instructional model; however, it was not created to be a model for teaching but to be a macro-model for reading comprehension (Gustafson, Samuelsson, Johansson, & Wallmann, 2013; Kirby & Savage, 2008; Savage et al., 2015). Gough and Tunmer's (1986) aim with SVR was to provide a reductionist formulaic lens through which researchers could test hypotheses or explain phenomena (Savage et al., 2015). This framework is not designed as an instructional model but rather a simple framework to understand the complex process of learning to read (Kirby & Savage, 2008). The framework serves two functions: a) it describes decoding and linguistic comprehension (vocabulary knowledge) as the two essential processes required for reading, and b) it provides a foundation on which to base reading interventions. Thus, SVR is useful for studies in speech, psychology, and education (Gustafson et al., 2013).

Studies supporting SVR come from three areas of research. The first area examines how decoding and linguistic comprehension affect reading comprehension in English but also in other languages such as Dutch (Verhoeven & van Leeuwe, 2012), Finnish (Torppa et al., 2016), Greek (Kendeou, Papadopoulos, & Spanoudis, 2012) and Turkish (Babayiğit & Stainthorp, 2013). The second area examines how decoding and linguistic comprehension correlate and what factors should describe SVR (Gustafson et al., 2013; Kendeou, Savage, & van den Broek, 2009). The third area examines significant research on students

who struggle with linguistic comprehension but have proficient decoding skills (Cain, Oakhill, & Bryant, 2004; Catts, Herrera, Nielsen, & Bridges, 2015; Massonnié et al., 2019; Y. G. Kim& Kim, 2017). The research on SVR indicates that SVR is a robust theoretical framework to describe the process of reading comprehension.

Decoding and linguistic comprehension are seemingly simple components of SVR. However, each component is a complex process that can cause one to struggle with reading comprehension (Savage et al., 2015). Poor reading comprehension is the result of weak decoding or linguistic comprehension skills or both. SVR states three conditions result in poor reading comprehension: a) adequate decoding skills but poor linguistic comprehension; b) sufficient linguistic comprehension but poor decoding skills; or c) poor decoding and linguistic comprehension skills (Verhoeven & van Leeuwe, 2012).

In summary, the *simple view of reading* is a theoretical framework to describe the process of reading comprehension. It combines decoding and oral comprehension as the foundations of reading comprehension. Since *Core5* focuses on decoding skills, vocabulary and linguistic comprehension, this study will use SVR as the theoretical framework to describe the process students go through to develop reading skills because this study investigates the effect of *Core5* on the development of decoding and linguistic comprehensions skills in kindergarten students.

1.7 Definition of Concepts

Blended learning: Blended learning is an instructional approach where students receive individualised instruction through computer-based programmes and receive teacher-led instruction either individually or in small groups (Macaruso et al., 2019).

Computer-assisted instruction: Computer-assisted instruction or sometimes called computer-based instruction is an intervention programme for reading or math that uses the computer to reteach and practise skills (Reed, 2013).
Differentiated instruction: Differentiated instruction is instruction based on the student's ability level without reducing the lesson's content (Gagliardi, 2011).
Early Literacy skills: Early literacy skills are the foundational skills needed to learn to read and write. These skills include print awareness, vocabulary, letter knowledge, phonological awareness, and comprehension or narrative skills (Macaruso & Rodman, 2011).
Reading intervention: Reading intervention refers to a program designed to fill any skill gaps in decoding, fluency or comprehension (Klubnik & Ardoin, 2010).
Response to intervention (RTI): Response to intervention is a three-tiered approach to meeting the instructional needs of all students. Tier 1 instruction is direct instruction in the classroom available to all students. Tier 2 instruction adds additional support through small group instruction or interventions to students who struggle with Tier 1 instruction. Tier 3 instruction is for students who are not progressing with Tier 1 and 2 instruction. This level consists of intense, frequent, pull-out interventions. Often students who are at the Tier 3 level of needs are referred for learning disability testing (Lim & Oei, 2015).
Scaffolding: Scaffolding is the process of modelling and assisting students until they can complete the tasks independently (Kim et al., 2010).
Struggling reader: Struggling reader refers to students who have deficient reading skills in decoding, fluency, and/or comprehension (Boulay et al., 2015).

1.8 Conclusion

The current study investigates *Lexia Reading Core5*® and evaluates its effect on kindergarten early literacy skills. Founded on the theoretical framework of the *simple view of reading* theory, the evidence from this study may influence policy changes to *Core5* implementation in the classroom.

Chapter 2 focuses on the literature used to lay the foundation of this study and includes research on the early literacy skills of decoding, fluency and oral comprehension. Also, research on specific early literacy interventions and computer-based or blended learning programmes provide a framework for this study.

The purpose of Chapter 3 is to explore the methodology of this study. This study is based on the research discussed in the literature review. The research design, sampling population and measures utilised are described in detail. Then the ethical considerations and research limitations are presented.

Chapter 4 presents the findings for the quantitative data collected from the three probes. The data is used to accept or reject the null hypothesis for the research questions.

Chapter 5 fulfils the purpose of the study by synthesising the key findings revealed in Chapter 4. The findings are discussed and compared with previous research on *Core5* and other blending learning programmes. The chapter reflects on the significance of the findings, and its implications on the *simple view of reading* theory and using CAI as an early literacy intervention. Finally, the chapter discusses the limitations of the study and where further studies could be done.

2 Literature Review

2.1 Introduction

A thorough understanding of the literature in literacy development, early literacy interventions, and blended learning or computer-assisted instructional (CAI) programmes will guide the evaluation of *Lexia Reading Core5®.* These three fields have a broad scope and research base, and so, this review of the literature will focus on research relevant to this study. The review will begin with an examination of the research on literacy development, such as the process of learning to decode words (Ehri, 2005: Ehri, 2014), and fluency (Hulme & Snowling, 2013). The work of Cadime et al. (2017), Tobia, Ciancaleoni, and Bonifacci, (2017) and Ribeiro, Cadime, Freitas, and Viana (2016) provide insight into the role of vocabulary on oral and reading comprehension. These strands provide the foundation of literacy for *Core5*. The research on early literacy interventions in decoding, comprehension, and blended learning provides evidence of which interventions work. The studies on previous Lexia Learning Products and *Core5* by Baron et al. (2019); Kazakoff, Macaruso, and Hook (2018); Macaruso & Rodman, (2011b, 2011a); Macaruso & Walker, (2008a); Macaruso et al. (2019); Prescott et al. (2018); Schechter, Macaruso, Kazakoff, & Brooke, (2015); Schechter et al. (2017); Wilkes, Macaruso, Kazakoff, & Albert, (2016) will be discussed in detail.

2.2 Early Literacy Development: Decoding

Decoding is word recognition or the ability to read a word quickly and accurately (Catts et al., 2015). The complexity of decoding is the ability to transform graphemes (letters) into sounds or phonemes, or looking at a spelling pattern and connecting that spelling pattern to a syllabic unit (Ehri, 2014). In order to do this, a reader must be able to combine orthography and phonology or phonics and phonologic awareness. The orthographic processor is the foundation of written language, and the phonological processor is the system of connecting sounds to written language (Paulson & Moats, 2010).

The ability to recognise sounds is crucial to have an understanding of the grapho-phonic relationship. The development of phonological awareness is the ability to recognise sounds in oral language. This process starts children along the path to distinguish the different words in oral language. As children's phonological awareness increases, they can distinguish parts of words such as syllables and rhymes. Finally, they can understand the phonemes within the word (Paulson & Moats, 2010).

Phonological awareness develops before reading readiness and letter identification skills, and it is one of the main predictors of reading abilities (Gellert & Elbro, 2017). It is common to screen kindergartners on their phonologic awareness in order to ensure that phonological skills are adequately developed. Adams (1990) attempted to bring organisation to phonological awareness by separating it into five different tasks: rhyming, alliteration, blending, segmenting and manipulation (cited by Wooldridge, 2017).

- The rhyming task requires the children to match, recognise or create a word that rhymes, (i.e., *cat/hat, fox/box*).
- In the alliteration task, a child identifies the words that start or end with the same phoneme or says the initial phoneme of two words (i.e., *truck/tree, /t/*).
- In the blending tasks, children combine the provided phonemes to create a word *(*/b/ /a/ /t/ into *bat***)**.
- In the segmenting task, the children break a word into phonemes (*bat* into */b/ /a/ /t/*) .
- In the manipulation tasks, children substitute one phoneme for another in a word or add a phoneme (i.e., *cat* change /c/ to /h/ equals *hat* or add /b/ to ‘at’ equals *ba*t).

The second step in decoding is the ability to connect sounds to letters or print code. When learning to read in an alphabetic language, children must connect phonemes (sounds) to graphemes (letters) which is the connection

between phonological knowledge and orthographic process (Ehri, 2014). The process of connecting phonology to orthography is described in phase theory (Ehri, 2005; Ehri, 2014): the memory of written words and spelling rules develop in phases that reflect the "predominant types of connections" (pg. 7) that help one remember words. The phases start with “pre-alphabetic” to full “grapho-phonemic and grapho-syllabic” (Ehri, 2014, pg.8). The four phases to develop fast word reading skills are pre-alphabetic, partial alphabetic, full alphabetic, and consolidated alphabetic phases. In pre-alphabetic reading skills, children recognise there is meaning in the squiggly lines, but they do not have an understanding of the alphabet yet. At this stage, children may pretend to read, but they are relying on visual cues or memory and cannot point to the word they may have just *read*. They may also *write*, but they are using scribbles or familiar letters and no letter-sound connections.

Children in the partial alphabetic phase can connect phonemes in spoken words to some letters. Usually, they can identify the initial and final phonemes. Children in this stage of decoding are usually able to decipher CVC (consonant-vowel-consonant) words like *mat*, *ran*, and *dog*. However, their knowledge of letter-sounds or grapheme-phoneme knowledge will be incomplete (especially vowel sounds). Thus, their decoding skills will be slow and probably inaccurate, and when they read unfamiliar words, they will rely on a combination of initial letters and visual cues. Their spelling also reflects their ability to recognise initial and final sounds.

The next step is the full alphabetic phase. Children know all the letter sounds and have an understanding of rhymes and spelling parts which facilitates fast, accurate word reading. In this phase, readers acquire more decoding strategies that help them recognise words with more automaticity because the spellings of words and their pronunciations are mapped into their memory. They can read the word as a single sound instead of sounding out the word letter by letter because the word is stored in their memory.

In the consolidated alphabetic phase, children can decode unknown multi-syllabic words. When students have reached this last stage, they should continue reading regularly in order to acquire a large vocabulary knowledge and to become fast, fluent, and accurate readers. At this stage, readers should have a good representation of phonological and orthographic relations and will access word meanings rapidly and accurately (Hamilton, Freed, & Long, 2016; Perfetti & Stafura, 2014).

Fluency is also an essential aspect of decoding, and oral reading fluency is considered the connection of word recognition and reading comprehension (Cadime et al., 2017). Studies have determined that the ability to read quickly in the lower grades influences reading comprehension among older students (Cadime et al., 2017; Kim & Wagner, 2015).

Letter name fluency (LNF) and letter sound fluency (LSF) is often used as a screening tool and monitoring process for kindergartners. When kindergartners take the LNF and LSF assessments, they are given a paper with alphabet letters in a random order, and they have one minute to recognise as many letter names or letter sounds as they can. Clemens et al. (2017) investigated the interrelations between the growth in LNF and LSF during the kindergarten year and how they predicted later reading fluency. This longitudinal study of 532 kindergartners to third-grade students was conducted in the United States and examined the impact of LNF and LSF knowledge on reading skills. The study used the AIMSweb LNF and LSF probe for the kindergartners and the Oral Reading Fluency (ORF) probe for first through third grade. The research revealed that having a higher LNF in the fall correlated with significant growth in LSF. The growth in both LNF and LSF was predictive of text reading fluency at the end of first grade, demonstrating the importance of LNF and LSF on decoding skills.

At the kindergarten level, alphabetic fluency or LNF and LSF measure and identify kindergartners who might require a reading intervention because LNF and LSF are considered an essential skill for children learning to read (Hulme & Snowling, 2013). The speed at which a kindergartner can identify the letter names

or letter sounds demonstrates efficient access to knowledge that is the foundation for higher reading processes. Therefore, letter name and letter sound fluency is a predictor of future reading success (Clemens et al., 2017). A study in Kenya examined the role of timing in fluency assessments (Piper & Zuilkowski, 2016). They administered the Early Grade Reading Assessment (EGRA) as a timed and untimed assessment to 4385 students. They discovered that the timed test was a good indicator for the students' decoding ability, and the students' comprehension did not improve with an untimed assessment.

While fluency is essential, activities should centre on building the knowledge base of letter names and letter sounds. Over-learning and automatic processing of letters and sounds make a difference in building skilled decoders (Erhi, 2014; Cadime et al., 2017; Hulme & Snowling, 2013). Until children have a solid base of orthographic and phonologic knowledge, their fluency will be slow. It is through the explicit instruction of phonemic awareness and phonics that children can read words with fluency.

2.3 Early Literacy Development: Comprehension

Language comprehension is the process in which a person can construct meaning from passages or conversation and connect it to their previous knowledge (Cadime et al., 2017). The process of understanding or extracting meaning from a conversation, a written text, or an oral text is complex because the process of comprehending a text relies on understanding the explicit information in the text and having a general knowledge of a topic (Massonnie et al., 2019). That process allows the reader or listener to make deductions about the text that are not explicitly stated and to create a mental representation of the text. Both reading and listening comprehension involves the cognitive processes of understanding the text lexile (word level, vocabulary, and idioms in the text), the text syntax (sentence level, grammar), and the implicit inferences in the text (Tobia et al., 2017). The reader must have the cognitive ability to understand single words and

create unity of those words in a sentence and combine that sentence with the other sentences in the passage to obtain comprehension of the text (Tobia et al., 2017). While there is an overlap between reading comprehension and listening comprehension skills, listening comprehension develops before reading comprehension and can predict reading comprehension abilities.

Both reading and listening comprehension are made up of two parts: text-based comprehension or local comprehension and global comprehension (Tobia et al., 2017). In local comprehension, readers understand explicitly given information or text level information. An example of text-level comprehension would be the ability to recall, in the story of the *Three Little Pigs*, which house of the three little pigs did not fall. In global comprehension, readers must be able to understand inferences, the goals of the writer, and use prior knowledge to understand or predict how the story will develop. An example of global comprehension, in the story of the *Three Little Pigs,* is the ability to infer each pig's character based on the house they built. Since the inference process helps readers to complete gaps in a text, it is an essential skill to have in order to understand the text.

Vocabulary plays a vital role in linguistic comprehension because it is the ability to understand the meanings of the words read or heard (Goch, Verhoeven, & Mcqueen, 2019). In order to comprehend a passage, a reader or listener must be able to understand most of the words (Ribeiro et al., 2016). Parents, pre-school teachers, and caregivers should play a role in developing vocabulary because vocabulary development is a predictor of reading comprehension (Braze et al., 2016) and children with a large amount of vocabulary have better reading comprehension than those with a limited vocabulary. These children also comprehend oral language better (Cadime et al., 2017), and their vocabulary knowledge enables their inference making skills (Silva & Cain, 2014). Another factor in learning vocabulary is having excellent phonological awareness because children can learn new words through recognising similar sounding words (Goch, Verhoeven, & Mcqueen, 2019).

One way to boost vocabulary in students is through shared book reading. *Shared reading* refers to a teacher and students looking at a book together and talking about about the story (Zucker et al., 2012). Participation in *extratextual talk,* or discussions about the text, impacts students' vocabulary knowledge. When teachers read to students in interactive ways, the students' language comprehension skills develop. In addition to vocabulary skills, when the teacher stops and asks students to predict what will happen next in the story, the teacher is teaching metacognitive skills like inferencing. Since language comprehension is different from the decoding process but still connected through phonological factors, language comprehension skills should be taught simultaneously with decoding skills (Goch, Verhoeven, & Mcqueen, 2019; Stuart, Stainthrop, & Snowling, 2008).

Lepola, Lynch, Kiuru, Laakkonen, and Niemi (2016) examined the role of oral language comprehension, task orientation, and decoding skills in predicting third-grade reading comprehension. In this five year study, the 90 participants were from Finnish preschools. The results from the study indicated that oral language comprehension, task orientation and decoding skills all contributed to reading comprehension. Oral language in kindergarten predicted oral language in third grade, but it had no bearing on third-grade reading fluency. Preschool oral language comprehension had a significant effect on third-grade reading comprehension.

Reading involves being able to both decode words on the page and understand what those words mean. Early literacy instruction should include decoding and oral language skills to prepare students to be successful readers. A successful kindergarten class will include systematic instruction in phonemic awareness and phonics. While students are learning to recognise the alphabet and their corresponding sounds, they also should be developing comprehension skills through listening to engaging texts and through participating in discussions or comprehension related activities with that text. By focusing on both decoding

and language comprehension, students will have a solid foundation on which to develop strong reading comprehension skills.

2.4 Response to Intervention

Response to Intervention (RTI) is a system of identifying student needs and providing high-quality instruction and interventions used in the United States (Clemens, Hilt-Panahon, Shapiro, & Yoon, 2012; Kim, Apel, & Al Otaiba, 2014). Student performance and rate of growth determine student needs. In the RTI model, student screening identifies whose performance levels indicate a need for instructional support or interventions (Oslund et al., 2012).

RTI has four essential components (Bianco, 2010; Gettinger & Stoiber, 2012):

- The first component is screening students to identify needs.
- The second component is matching a student's educational or behavioural needs to a tiered level and corresponding research-based interventions.
- The third component is progress monitoring using a valid probe to assess student growth.
- The fourth component is using progress monitoring data to make educational decisions on changes in instruction, goals or referrals for special education.

The RTI process can be used for educational needs and behavioural needs. Reading and math skills are commonly assessed for skills gaps. In reading, RTI is used to implement early literacy interventions in kindergarten and first grade to combat reading problems and improve reading skills in at-risk students (Clemens et al., 2012).

Screening at the beginning of the school year provides teachers and school administrators a snapshot of the instructional needs of their students. In the RTI

model, instruction is divided into three Tiers (Margolis, 2012). The average and above-average students receive core instruction in the classroom. Tier 1 instruction is core instruction. Students who need additional support because of below-average achievement would receive Tier 2 interventions. Tier 2 interventions are provided in a small group setting and involve more instruction than Tier 1. Students in the Tier 2 level receive both Tier 1 instruction and Tier intervention.

If students still are not making progress with a Tier 2 intervention, then they are recommended for Tier 3 instruction. Tier 3 is often a daily, explicit or direct instruction intervention that replaces the Tier 1 instruction. Tier 3 is sometimes called core replacement. If students do not make progress with Tier 3 instruction, then a special education referral is made.

Progress monitoring is a crucial part of the RTI process as student progress is monitored throughout the intervention to assess the intervention's impact on student growth (Clemens et al., 2012). To effectively implement the RTI process, valid progress monitoring measures must be used (Clemens et al., 2012; Oslund et al., 2012). It is the progress-monitoring measures that inform teachers and school administrators if the interventions are working. When a measure indicates that student is making progress, then decisions of continuing or discontinuing that intervention may be made. On the other hand, if the progress monitoring measures indicate the student is not making gains or even worse, regressing, then decisions to change or modify the intervention need to be made (Oslund et al., 2012). The progress monitoring allows teachers to track the progress of individuals and use this information to support all children through instructional modifications (Gettinger & Stoiber, 2012).

Progress monitoring tools need to be accurate, reliable and efficient. If the measure has low reliability and validity, then students will be identified wrong and placed incorrectly (Clemens et al., 2012). The measures used directly impact the students the RTI process serves (Margolis, 2012). It is the validity of a progress-monitoring measure that enables teachers and school administrators to have

confidence in their decisions on student placement and interventions (Oslund et al., 2012).

Measures also need to be easy to administer, and the results easily interpreted and recorded. Because students in Tier 2 and Tier 3 need to be progress monitored weekly, the measures need to be quick and easy to administer to avoid taking time away from instruction (Margolis, 2012). Additionally, the data must be easy to interpret and used to adapt instruction or make educational decisions (Gettinger & Stoiber, 2012; Margolis, 2012).

The progress monitoring tools used depend on the school and the school district. Some schools use assessments not related to curriculum or interventions, curriculum-based measurement (CBM) assessments of skills, or measures provided by the reading intervention (Oslund et al., 2012). CBM is the commonly used progress monitoring measurement because the measures are quick to administer, and they are inexpensive, and CBM assessments use standardised procedures ensuring reliability and validity (Clemens et al., 2012). In kindergarten, commonly used measures are letter name fluency and letter sound fluency. The gains children made on these measures have shown to have validity in predicting the reading skills of the children (Clemens et al., 2012).

Kim, Apel and Al Otaiba (2014) investigated the relationship of the RTI levels and the outcomes on phonological, orthographic and morphological awareness and vocabulary assessments. There were 304 first-grade participants assigned to a Tier 1, Tier 2, or Tier 3 interventions based on their scores at the beginning of the school year. The results at the end of the study indicated that the level of intervention did not have predictive value on phonological, orthographic, and morphological awareness skills. However, it was a predictive variable on vocabulary and spelling.

In summary, RTI is a system used to identify individual educational needs and help educators decide what level of intervention to provide to individual students. Progress monitoring is an essential part of the RTI process to monitor the growth of students. The growth on commonly used progress monitoring tools

LSF and LNF can be predictive of future reading skills and early literacy interventions are usually administered based on the RTI system.

2.5 Early Literacy Interventions

In a perfect world, students would quickly absorb the reading skills taught in kindergarten and not fall behind in their reading skills. However, a large number of students enter kindergarten at risk of not learning necessary literacy skills. Often these children are economically disadvantaged. Unfortunately, the reading gap between low performing students and high performing students continues to increase each year (Noltemeyer, Joseph, & Kunesh, 2013). Thus, early literacy interventions must occur at the kindergarten level. Quality early literacy interventions can help prevent kindergartners with low literacy skills from having significant delays in learning to read and lessen the gap between low performing readers and high performing readers (Notlemeyer, Joseph, & Kunesh, 2013). Phonics instruction, fluency drills, and vocabulary development help to prevent failure in learning to read.

Explicit instruction in decoding skills should begin in kindergarten to help at-risk children to improve their success at reading. Whole group instruction may move too quickly for children who are struggling learners. Thus, children may need additional instruction targeting the individual skills those children may be missing. This instruction should be in small groups. Many schools and educators use small group instruction as a way to address specific needs that kindergartners may have.

Noltemeyer, Joseph, & Kunesh (2013) examined the effects of additional phonics instruction in small groups. The study was conducted in the United States, with six kindergartners divided into a control and treatment group. The results of the study indicated that 10 minutes of additional instruction twice a week did not provide enough time for the reinforcement of skills. While the kindergartners could recall words immediately following the 10-minute instructional session, many gains

were lost within a week. Short sessions are not productive, and the researchers suggested that supplemental instruction is delivered three to five times a week for a minimum of 20 minutes. This suggestion supports the findings by Hudson et al. (2011) that interventions in decoding skills, phonemic awareness, and letter-sound knowledge will improve children's literacy skills if that intervention occurs at least three times a week for at least 20 minutes. Reading interventions for low performing kindergartners should be consistent over the entire school year, especially for kindergartners who did not attend pre-school.

Any early intervention-reading programme must be implemented with fidelity for it to be successful. Implementation fidelity refers to the intervention programme utilised as intended by the researchers or developers (IrisCenter, 2019). A programme is implemented with fidelity when it meets the following criteria:

- Adherence: the elements of the programme are used as designed
- Exposure: the recommended minutes and frequency are followed
- Quality of delivery: the teacher/interventionist delivers the programme as designed
- Responsiveness: students are engaged in the content (Benner, Nelson, Stage, & Ralston, 2011).

In other words, for a programme to be implemented with fidelity, the teacher/interventionist must use it as intended and ensure students receive the programme for the recommended time and frequency. Benner et al.'s (2011) study on the fidelity of implementation examined how implementation influenced the outcomes of the reading intervention *Corrective Reading* with 281 fifth through eighth-grade students in the United States. The results from the study revealed that fidelity of implementation accounted for 22% of the variance in reading skill gains indicating that using a programme as intended does play a role in student gains.

Several factors influence implementation fidelity. Stein et al. (2008) and Fogarty et al. (2014) explored these factors. The first factor is the teacher's experience. Interestingly, new teachers are more likely to use a programme with fidelity because, unlike experienced teachers, new teachers do not have a repertoire of strategies they have acquired over time. New teachers are more open to suggestions and are more willing to follow prescribed strategies. They also have not formed deep-seated opinions towards specific strategies or programmes.

The second factor is the social context of a school. The leadership of the school, a positive school climate, and communication between administration and teachers influence the willingness and ability of teachers to implement new programmes with fidelity. Leadership places a crucial role in encouraging teachers to try new programmes as well as supporting teachers by providing the necessary resources to implement the programme. High-quality professional development is necessary to support teachers as they implement new practices. Finally, if an intervention aligns with the current curriculum, then teachers are more apt to implement the intervention with fidelity (Stein et al., 2008).

2.5.1 Decoding

It is crucial to target the phonological and orthographic processes through the explicit teaching of early literacy skills and intensive interventions for those at-risk learners. Decoding interventions, such as phonemic awareness, phonics, and fluency, are beneficial for young learners (Suggate, 2016). Phonemic awareness interventions target sound awareness (i.e., the phonemes in words like *cat* /k/ /a/ /t/), and phonic interventions teach the relation between the phonemes and orthography. Lastly, fluency interventions focus on increasing the speed and accuracy of the words or sounds read (Suggate, 2016).

Phonological awareness is a crucial component of reading development, and children with deficits in phonological awareness struggle with learning to read (Ring, Avrit, & Black, 2017). Interventions need to provide instruction in both

phonological awareness and phonics or letter-sound correspondences to improve decoding and reading skills (Ring, Avirt & Black, 2017). The ability to manipulate sounds in different ways, such as blending or deleting sounds is one component of phonological awareness that struggling children need direct instruction (Giess, Kennedy, Rivers, & Lombardino, 2012).

One programme for teaching struggling readers, especially those with dyslexia, is the Orton Gillingham (OG) multisensory language approach (Giess et al., 2012; Ring, Avrit & Black, 2017). Dr Samuel T. Orton created this curriculum for students who needed a systematic phonic-based reading instruction. OG's approach to reading instruction emphasis teaching individual phonograms and the rules for blending them. Each unit of language is taught from the simplest form to the more complex unit of language. The units are also taught with multisensory visual, auditory and kinaesthetic information.

A couple of reading interventions have based their curriculum on OG's approach for reading instruction. *Barton Reading and Spelling System* and *Take Flight* are two programmes based on OG's principles. There has been little research on both OG and OG-based reading interventions (Giess et al., 2012). A What Works Clearing House report (2010) stated that no studies of the *Barton Reading & Spelling System* (BRSS) occurred that met the What Works Clearing House evidence standards.

Researchers Giess et al. (2012) studied the impact of BRSS on nine high school students. Each student received BRSS intervention one-on-one with a tutor. BRSS is divided into ten levels starting with phonemic awareness and moving on through different decoding and spelling rules of the English language. The pretest-posttest gains indicated BRSS had a medium effect size on spelling and sound awareness. It had a large effect size on the students' word attack skills. However, there was only a small effect size on sight words and phonemic decoding. Based on the study, BRSS seems to be an effective programme for struggling readers. One downside to this programme is that it is taught individually and not designed for small group instruction.

Ring, Avrit, and Black (2017) investigated the effectiveness of *Take Flight* when compared to *Dyslexia Training Program* (DTP), a previous OG programme. This programme is based on the OG approach but designed for small group instruction. The systematic instruction of the programme includes phonological awareness, reading and spelling, fluency and the structure of written English. The study indicated that the participants in the *Take Flight* group had more significant gains than the DTP group. In particular, the participants in the *Take Flight* group had a 10 point greater gain than the DTP group.

All children should receive phonological training starting in kindergarten (Kilpatrick, 2016). By training all children, future reading difficulties are minimised. Additionally, children trained in phonemic awareness read more quickly in first and second grade (Kilpatrick, 2016). Based on this principle, Dr Heggerty and his business partner, Thomas Corless, designed the Heggerty Phonemic Awareness Curriculum, also known as just Hegggerty (Heggerty, 2019). This phonemic awareness instructional curriculum is designed as a Tier 1, whole group instruction. Each lesson takes 10-12 minutes and focuses on eight phonemic awareness skills: rhyming, onset fluency, blending, identifying sounds, segmenting, adding and deleting phonemes, and substituting phonemes. The programme incorporates the OG principle of multi-sensory instruction. Each activity has a corresponding hand motion. Children listen and must respond according to the activity, i.e. say the two out of three words that rhyme. Lastly, there are letter cards for the students to practice the letter-sound correspondence.

While Heggerty is based on phonemic awareness research, there is limited research on how effective Heggerty is at increasing phonemic awareness or how it might improve reading skills. Wagner (2017) investigated how Heggerty impacted pre-schoolers' rhyming abilities. While the curriculum is designed as a 35-week program, the treatment period in this study was only seven weeks. However, the results indicated that 93% of the participants improved in rhyming skills from pretest to posttest. Interestingly, the male participants made more growth than the female participants with the male mean score increasing from 8.18 to 11.13 points

while the female mean score increased from 9.88 to 10.77 points. Some issues with this study are the small participant size (n=31) and the short treatment period. Another limitation is that it only looked at rhyming skills and did not examine the other seven strands of Heggerty.

Phonological awareness instruction is effective for students learning English as a second language. Yeung et al. (2013) investigated how language-enriched phonological awareness instruction impacted the gains of Chinese ELL children in phonological awareness, oral language proficiency, reading and spelling. The participants were 76 children from three kindergarten classes. There were 38 children in the treatment group and 38 children in the control group. The participants all spoke Cantonese at home and only spoke English at school. The treatment included instruction in syllable segmentation, rhyming, blending and sound awareness. The control group received whole word learning instruction. At the end of the 12-week treatment session, there was a statistically significant difference in word reading, spelling, and phonological awareness activities like syllable deletion and rhyming. There was no statistical difference in oral language proficiency and letter identification. Based on the evidence, the researchers concluded that providing the phonological awareness instruction facilitated reading in English for the Chinese ELL children.

In languages like Finnish, Dutch, and German that have transparent orthographies (a spelling system where one letter has one sound), knowing the alphabetic principles are enough for students to learn to decode in those languages. However, in English, there are many exceptions to the grapho-phonemic rules (such as *yacht, know*). Being able to decode enables students to read most words in the context of a sentence; however, they also need to learn the sight words through repeated interactions in the text they are reading.

The study by de Graaff, Bosman, Hasselman, & Verhoeven (2009) investigated the benefits of teaching phonics systematically to Dutch kindergarten students. This study provided evidence that teaching phonics in a systematic manner increases students' skills in phonemic awareness, spelling, and reading.

Since the Dutch language has a transparent orthography, it was assumed that the students in the control group would make the same gains. However, the systematic-phonics approach led to better results. This finding suggests that languages with a more complicated phonics structure (such as English) would benefit even more with a systematic phonics approach. Graaff et al. (2009) explain that the systematic instruction of phonics enables beginning readers to learn the "functional relationship between orthography and phonology" (pg.330). When the functional relationships are learned, then beginning readers understand the alphabetic principles and can decode unknown words.

In a study on fluency, Hudson et al. (2011) investigated decoding accuracy on improved reading skills in seven schools in Florida. Fifty-eight second-grade students participated in the study. The study examined the effects of small-group instruction in phonemic awareness, letter-sound correspondence and word families with at-risk second graders on their fluency. The study indicated that focusing instruction on the accuracy of letter sounds, word-patterns (*-ake*, *-ain*), and sight words increase text-reading fluency on cold reads (text that students have not previously read). In this study, focusing on accuracy had more significant gains than focusing on automaticity.

Wanzek et al. (2018) conducted a meta-analysis on intensive early reading interventions. This study updated previous findings on intensive early reading interventions. The 24 studies were organised by size, grade, frequency, duration, group size, and implementation. The results of the meta-analysis indicated that intensive early reading interventions of 100 or more sessions do have significant gains in reading performance. Across the studies with positive gains there were three similarities: a) there was a high level of implementing the intervention with fidelity (consistent instruction); b) interventions targeted toward phonological awareness, phonics, word recognition, and fluency; and c) school staff, not the researchers, implemented interventions.

An example of an early interventions programme is *Reading Recovery*. The students are placed in the programme by completing six different tasks:

- Text reading;
- Letter identification,
- Concepts about print
- Word frequency test
- Writing vocabulary test
- Hearing and identifying sounds in a word

The programme is delivered five times a week for 30 minutes a day for a period of up to 20 weeks. The goal of the programme is to develop reading and writing strategies that help the student become an independent reader and writer. Jesson and Limbrick (2014) examined *Reading Recovery* in New Zealand. They investigated the achievement of students who had completed *Reading Recovery* and discovered that 84% of students who started the programme were able to complete it. Of those students, 60% remained at grade level and did not fall behind in future grades.

Another programme, *Reading Mastery*, is an effective direct instruction intervention for struggling students, English Language Learners, and students with disabilities. This programme is a comprehensive reading intervention programme because *Reading Mastery* teaches decoding and comprehension skills. It is different from other programmes because it uses a unique orthography designed to assist students with all the sounds used in English. A unique font is used for the 'different letters' and is eventually phased into traditional orthography as students progress in their reading abilities. The programme lasts an entire year, and the daily lesson session is about 35-45 minutes. Kamps et al. (2016) examined the effects of *Reading Mastery* with beginning readers in kindergarten. School-based instructors implemented the programme with fidelity in small groups of 30 students. The results indicate that students receiving the *Reading Mastery* intervention had significantly more growth in letter-sound knowledge and word identification abilities than the control group.

A study conducted in the United Kingdom on the programme *Reading Intervention* found significant gains in phonological awareness and reading skills (Duff, Hayiou-Thomas, & Hulme, 2012). *Reading Intervention* was developed by Hatcher, Hulme and Ellis in 1994 and involved phonological awareness and letter-sound relationship instruction. The developers based their programme on the idea that there is an explicit link between phonological awareness and reading. Thus, those skills need to be taught together. In Duff, Hayiou-Thomas and Hulme's (2012) study, they compared the growth of children with reading difficulties using the *Reading Intervention* programme over a ten-week treatment period with the children in the regular classroom. The participants were from five to seven years old and from eight primary classrooms. There were 30 participants in the control group and 29 in the intervention group. While participants in both groups made gains from pretest to posttest, the participants in the treatment group made significantly more growth in early word reading, phonetic spelling and phoneme awareness. The study concluded that the intervention was effective on phoneme awareness, reading and spelling, but once the intervention ended, the rate of progress dropped, and the progress was not sustained when compared to the control group. However, the control group did not have reading difficulties which probably contributed to their ability to keep progressing when compared to the treatment group. Thus, struggling readers often need reading interventions for extensive time to keep up with their reading peers and not fall behind.

In conclusion, the evidence supports interventions in phonics, phonemic awareness, and fluency to build reading success. For an intervention to be successful, it needs to take place several times a week for 20 or more minutes and must be implemented with fidelity.

2.5.2 Language Comprehension

As previously discussed, students cannot comprehend text if they cannot decode. Equally important to understanding text is having the vocabulary and

contextual knowledge necessary to understand the words and inferences in a text. Most reading interventions focus on developing the student's ability to decode; however, explicit vocabulary instruction or interventions should also be part of a student's literacy development. Vocabulary learning is crucial to reading and “cannot be left to chance because students' word knowledge affects whether they comprehend what they are reading" (Tompkins cited in Mixan, 2013, pg. 120).

According to Vadasy and Sanders (2016), developing vocabulary knowledge can reduce the gap in disadvantaged students, but usually, a kindergarten classroom does not provide enough direct instruction needed to promote vocabulary growth. In Vadasy and Sanders’ (2016) study, the students received an intervention delivered by a para-professional tutor using high-frequency vocabulary words in multiple sentence contexts as well as practising with the words in oral responses (Vadasy & Sanders, 2016). The findings from this study support previous research (Carlson, Jenkins, Li, & Brownell, 2013) that the use of vocabulary interventions is a way to increase word knowledge.

Multiple studies have confirmed the correlation between extensive vocabulary and reading comprehension (Braze et al., 2016; Hemphill & Tivnan, 2008; Perfetti & Stafura, 2014; Tunmer & Chapman, 2012). Students quickly learn new vocabulary from incidental learning which occurs when they are listening to conversations or when they listen to a read aloud. When teachers read to students, they expose their students to new words. Through repeated interactions with the new words, students acquire new vocabulary (Mixan, 2013). Repeated readings, read alouds, word walls, and literacy-related games all help develop vocabulary (Mixan, 2013).

The study by Hemphill and Tivnan (2008) examined the role of vocabulary and early literacy skills (decoding) interventions on first-grade students. The predictors of these interventions were tracked until third grade. The results showed that letter-word identification and word reading fluency skills were the best predictors of reading comprehension at the end of first grade. However, once students started reading to learn in second and third grades, vocabulary was the

best predictor of comprehension. Hemphill and Tivnan (2008) reported that weak vocabulary limited the students' reading comprehension growth and contributed to the decline of national norms in second and especially third grade. Thus, vocabulary is crucial to future reading success and should be part of an early literacy curriculum.

Vocabulary instruction is essential, but it does not necessarily transfer to other language skills (Haley, Hulme, Bowyer-Crane, Snowling, & Fricke, 2017). Researchers Haley et al. (2017) investigated the effectiveness of a language intervention programme in 13 UK nursery schools on improving standardised language measure scores and oral listening skills. The treatment period for the 104 participants was 15 weeks. Gains were assessed via a pretest-posttest assessment and included vocabulary knowledge, listening comprehension, narrative, grammar and speaking skills. The treatment group received the Nursery L4R intervention for 15 weeks. This programme consists of three 20-minute sessions a week focusing on a listening game, vocabulary and narrative skills. The results indicated that the treatment group only showed significant improvement with directly taught vocabulary when compared to the control group. On the rest of the measures, there was slight to no statistical difference between the two groups. The implication from these findings is that vocabulary interventions alone is not enough to improve oral listening comprehension and other language-based skills adequately.

Shared readings (interactions and discussions between an adult and a child while reading a book together) are an essential mechanism for building language and literacy (Zucker et al., 2012). For shared readings to be effective, they must take place consistently, over extended periods. Zucker et al. (2012) examined the frequency of shared reads and the interactions on vocabulary growth and literacy development. The study supported previous research that indicated exposure to extensive and sophisticated vocabulary in a text increases a student’s vocabulary development. The frequency of readings did not affect decoding skills. The most salient finding was that the teacher’s extra-textual talk

played a role in language development. The extra-textual talk was positively associated with the student's expressive and receptive vocabulary and reading comprehension.

Using the idea of shared readings, researchers Beck and McKeown (2007) developed an instructional method called *Text Talk*. The programme develops vocabulary through the shared reading of trade books. *Text Talk* was developed and tested by Beck and McKeown (2007) on kindergarten and first-grade students. In the first part of the study on using *Text Talk*, Beck and McKeown measured the growth of vocabulary between the students receiving *Text Talk* instruction and the control group. Students in the treatment group learned three times as many words those in the control group. In the second part of the study, Beck and McKeown examined if more encounters with the vocabulary words in different contexts would contribute to better retention of the vocabulary word. The results supported the hypothesis that multiple interactions in different contexts increase vocabulary retention.

Mckeown and Beck (2014) continued the study on *Text Talk* using two vocabulary instructional approaches: repetition and interactive. Repetitive vocabulary instruction featured repeated readings of one story and then practice with vocabulary definitions. The interactive approach consisted of multiple interactions of the vocabulary word in different contexts, followed by active processing of that word in the different texts. The study concluded that kindergarten students in both instructional methods increased their vocabulary, but the students who learned vocabulary through contextual information were able to produce words associated with pictures and different contexts. The results suggest that effective vocabulary instruction should promote active processing. The results also indicated that students in both groups could learn sophisticated vocabulary through repetition or interactive instruction.

One instructional practice that is easy to implement and improves young children’s language skills is storying telling and acting (Snow & Matthews, 2016). In this instructional practice, children retell the stories previously read to the

teacher or partner, and while the teacher reads stories, the children act them out. Children who participated in telling and acting showed more significant gains in comprehension, vocabulary and the ability to pretend because the telling and acting helped the children to develop their language and literacy skills. Telling and acting can easily be combined with extra-textual talk, and both these techniques can be implemented without any additional curriculum.

In addition to enriching vocabulary, extra-textual talk in shared reading is crucial to demonstrating inferential skills. Drawing inferences is crucial to understanding many higher-level texts, and it is often difficult for students to complete. Inferencing is vital from an early age. While inferences do rely on other language skills like vocabulary and grammar, vocabulary, and grammar alone are not enough to ensure inference making (Silva & Cain, 2014). The study by Silva and Cain (2014) examined how vocabulary and grammar knowledge affected inference making, and whether inference making could predict reading comprehension one year later. The results showed a strong relationship between vocabulary and inference making. Vocabulary is necessary to understand explicitly stated information, and as a story progresses, students with a broader vocabulary based can access a greater range of associated concepts and can make more inferences. Additionally, students who can make inferences are often able to learn or guess what new vocabulary words mean in a text. The researchers did not find grammar to be strongly related to inferences, but it was essential to understand individual sentences and did contribute to later reading comprehension success.

Researchers Clarke, Snowling, Truelove, and Hulme (2010) examined the efficacy of using text-comprehension training, oral-language training and a combination of text and oral language training. The treatment was three 30-minute sessions for 20 weeks. Each session had activities built around a text. The text-comprehension intervention comprised of inferring, clarifying unknown words, reciprocal teaching with the text and metacognitive strategies like reread, visualise, and self-explanation. The oral intervention included vocabulary instruction, reciprocal teaching with spoken language and figurative language. The

combined intervention integrated all the components from the other two programmes. While all three groups made more significant gains than the control group, the oral language group had the most significant gains. The results from the study add to the evidence of the importance of oral language skills in reading comprehension.

A meta-analysis of reading comprehension interventions found that teaching meta-cognitive skills had positive results on linguistic comprehension (Melby-Lervåg & Lervåg, 2014). Chlapana (2016) examined the role of KWL charts (What I know/What I Want to Know/What I Learned), reciprocal teaching and dialogical reading in enhancing cognitive engagement and improving comprehension on informational texts with kindergartners. This study took place in Crete kindergarten classroom of 15 children. The treatment period was two months with a four-phase intervention. The first phase lasted one week and consisted of different activities that familiarised the children with the texts they would be reading. In the second phase, the teacher implemented reciprocal teaching. The teacher used puppets to role model how to predict, clarify, question and summarise. The children practised the skills following the teacher's role modelling for four weeks with the KWL practice in the third phase. The teacher modelled how to fill in the first two sections of the chart. Then the text was read. While reading the text, the teacher asked questions to help the children engage with the information and vocabulary. Then, they completed the last section of the chart, and the children were encouraged to discuss if their learning expectations were met. The final phase was the dialogic reading. In this phase, the skills learned in the previous phases were incorporated. The children were encouraged to ask questions, make predictions, summarise and use their background knowledge to connect with the text. There was no pretest or posttest to determine if the children's cognitive or comprehension abilities improved. Instead, the researcher recorded the sessions and tracked the participants' responses. Based on the participants' responses, the Chlapana (2016) concluded that the intervention had a positive effect on the children's comprehension and that the

children's cognitive involvement in the discussions improved as they progressed through each phase of the intervention.

In summary, explicit vocabulary and inference instruction should be part of every kindergarten class because it is necessary for reading comprehension. Instruction should occur through multiple shared readings. Children need to hear vocabulary in multiple contexts, and they need to be taught how to make inferences through teacher talk.

2.6 Blended Learning and Computer-Aided Instructional Programmes

Blended learning is an instructional approach that incorporates student-led digital programmes with teacher-led instruction, giving students some control over how quickly they cover the content (Kazakoff, Macaruso, & Hook, 2018). In blended learning, the students have control of how quickly they move through the content. Through this type of instruction, teachers can effectively differentiate instruction by matching students with the instruction they need. The data provided from the programme enables teachers to manage the student's progress and target the student's individualised needs. Blended learning allows teachers to differentiate instruction based on how their students are progressing (Kazakoff, Macaruso, & Hook, 2018).

Blended classrooms are beneficial to diverse groups of learners, such as ELL students, because blended classrooms meet the needs of both the student and the teacher by enabling the teacher to provide targeted instruction (Powell et al., 2015; Prescott et al., 2018). Blended learning may provide students who have gaps in their reading or math skills the opportunity to enhance those skills and close their learning gaps (Prescott et al., 2018).

Blended learning is administered in several different ways based on the teacher, classroom environment, learning goals and access to technology. The standard way elementary classrooms implement blended learning is through the

rotation model which includes station rotation, lab rotation, flipped classroom, and individual rotation (Kazakoff, Macaruso, & Hook, 2018; Powell et al., 2015).

Station rotation involves the students moving from one station to another. A small group may be using the computers while another small group is receiving instruction from the teacher. After a certain amount of time, the groups switch. Station rotation is a common choice in elementary classrooms because it builds on the traditional model of moving through activity centres (Kazakoff, Macaruso, & Hook, 2018).

Lab rotation involves all the students using the computers at the same time as part of the class (Powell et al., 2015). In an elementary setting, the whole class might go to the computer lab. Sometimes the classroom has access to Chromebooks or other such devices, and the lab rotation can be implemented without leaving the classroom.

A flipped classroom is when students use the online learning or CAI programme outside of classroom instruction (usually at home as part of their homework) and come to school for the teacher-directed practice, or projects (Powell et al., 2015). In this model, students learn the content online and do the practice at school with the help of the teacher.

Individual rotation is when each student has an individualised schedule of activities (Powell et al., 2015). The student may not rotate through all stations or do all the activities in the classroom. An example of this in an elementary setting is an ELL student using a vocabulary instructional programme while the rest of class does morning work of completing a worksheet.

According to Powell et al. (2015), other models of blended learning include the flex model, a la carte model and enriched virtual model. In these three models, the majority of the learning takes place online, and teachers are only there to provide help. In the flex model, students are at a brick and mortar school, but the instruction comes via online learning. With the a la carte model, students may take the class either at a school or home, and the teacher provides instruction via the online programme. In the enriched virtual model, students are required to have

face-to-face learning with their teacher and then are free to complete the rest of the course as they wish. These models are not as common in elementary schools except in small rural communities where access to qualified teachers is limited.

One case study highlighting the benefits of blended learning took place at the Spring City Elementary Hybrid Learning School (Evergreen Education Group, 2015). The school used the station rotation model of blended learning with students rotating every 20 minutes. The students used the online curriculum for 20 minutes, and the teachers used the data from that programme to create small groups for direct instruction. The school used a variety of programmes to enhance math and reading skills. Since the implementation of blended learning, the school's test scores on the Pennsylvania System of School Assessment have risen, especially among students who have an individualised education program (IEP). The percentage of students who were scoring at the *proficient* level or *advance* level on reading increased by 19 points to 82%, it increased by 24 points to 85% on math, and it increased by 27 points to 90% on science.

Technology is becoming a common aspect of the classroom, especially as blended learning is becoming more popular (Prescott et al., 2018). Teachers should attempt to incorporate technology as part of their instructional model. Researchers Powell et al. (2015) state “Blended learning should be viewed as a pedagogical approach that combines the effectiveness and socialisation opportunities of the classroom with the technologically enhanced active learning possibilities of the online environment […]. In other words, blended learning should be approached […] as a fundamental redesign of the instructional model” (pg. 6).

Successful implementation of blended learning includes four key components. The first component is teacher training. School administrators need to ensure that teachers can effectively implement blended learning components (Hilliard, 2015). The second component is the resources. Leaders need to provide online resources or programmes that meet the pedagogical goals of the class and provide the infrastructure to access these programmes (Hilliard, 2015). The third component is the continuous evaluation of the online resources for their

effectiveness on student achievement (Hilliard, 2015). The fourth component is an understanding of how to integrate technology in the classroom effectively. Blended learning is more than just having technology in the classroom. It is integrating student-directed online learning with offline, teacher-directed instruction (Vaughan, 2014).

In order to implement a blended learning instructional approach in the classroom, one must have a digital programme addressing the skills that need instruction. Computer-assisted instructional (CAI) programmes are computer applications that teach specific skills. CAI is useful for teachers to use as part of an enrichment or intervention plan because it provides predictable instruction and rewards, which may increase motivation. Additionally, teachers can usually implement the programme with high fidelity (Ozen, Ergenekon, & Ulke-Kurkcuoglu, 2017). Teachers can also use CAI to differentiate student needs. A quality CAI programme will engage students and enable them to learn independently because teachers can customise the instruction by adjusting levels, or assigning activities to meet individual learning needs (Cullen, Alber-Morgan, Schnell, & Wheaton, 2014). This is necessary when setting up a blended learning environment. CAI is also highly effective with students who have a learning disability because it provides predictable instruction, it helps increase focus by eliminating distractions, and it is simple to implement (Ozen et al., 2017).

While research supports using CAI as part of a blended learning environment, it takes more than just having access to technology to create a positive blended learning environment. Just having access to a CAI programme does not directly lead to the high fidelity of implementation in the classroom because success in new implementation in educational technology programs depends on the teachers' attitudes (Raman, Malik, & Omar-Fauzee, 2015). While most classrooms have computer access, teachers are not utilising them as they could. A recent study of Dutch education showed that 50% of teachers spent at least 10 hours a week using technology but it was mainly for simple tasks like presentations and resource materials (Farjon, Smits, & Voogt, 2019). Frequent

use of technology and a belief in technology is not having the effect it should. Teachers control the impact technology has on student learning, and unfortunately, teachers are not effectively using technology in their classroom (Blackwell, Lauricella, & Wartella, 2014). Thus, the focus needs to be on helping teachers learn how to use digital tools effectively (Schechter et al., 2017).

What is preventing teachers from implementing CAI programmes in ways that support student learning? According to Blackwell, Lauricella and Wartella (2014)“Intrinsic barriers, such as preexisting teaching beliefs, attitudes toward the educational value of technology, and comfort with technology” (pg. 82) all influence technology use. Teachers' attitudes influence how quickly an instructor will adopt new CAI programmes, and their attitudes are a significant predictor of student use in the classroom. The teachers’ attitudes affect their enthusiasm and willingness to implement the programme in the classroom, and that enthusiasm is transferred to their students (Bii, Too, & Mukwa, 2018). It is vital to explore teachers’ attitudes towards technology in order to generate the desired implementation of CAI programs (Ozer, 2018).

Jones (2017) found that teachers who had a robust pedagogical knowledge struggled to implement technology that conflicted with their pedagogical beliefs. Teachers who believed in human interaction and limiting screen time tended to have negative attitudes toward educational CAI programmes (Jones, 2017). Another study in primary schools in the Netherlands found that an essential factor influencing teachers' attitudes on technology was their confidence (Rohaan, Taconis, & Jochems, 2012). The more experience and training teachers received in using CAI programs, and the more confident and positive the instructors were towards educational technology (Rohaan, Taconis, & Jochems, 2012). Farjon, Smits, and Voogt (2019) found that the attitudes and beliefs of pre-service teachers had the most substantial influence on their technology integration. Even when they added experience or training, attitudes still predicted teachers’ CAI programme usage.

In Blackwell, Lauricella, and Wartella's (2014) study of 1,234 early childhood educators showed that attitudes toward technology for children's learning and confidence in using the programme had the most potent effect on whether a programme was used in the classroom. They also discovered that teachers who worked with children from low social, economic status (SES) had positive attitudes towards using technology. On the other hand, teachers who taught students from high SES backgrounds had negative attitudes towards technology. The researchers hypothesised that low SES students probably enjoyed the access to technology not available at home, and teachers who worked with them viewed the technology as a way to give the students critical technology experiences.

Taimula and Luik (2019) examined the impact of beliefs and experience on technology implementation. The results supported previous research on teacher attitude and technology integration. Teachers who have more traditional teaching ideas do not believe technology is useful, while teachers who have more constructivist beliefs are better at using technology. One interesting result from the study indicated that there was no direct effect between one's belief about the value of technology and its implementation. In other words, teachers can believe a program is helpful but view it as time-consuming and not worth the effort. The latter attitudes would prevent a teacher from using technology (Taimalu & Luik, 2019).

Research suggests that CAI is a useful intervention tool. The meta-analysis by Cheung and Slav (2013) examined the effectiveness of CAI programmes in improving the reading skills of struggling elementary readers and included 20 studies based on 7,000 students in grades 1-6. This study examined different programmes and analysed the effect size of each programme. The effect size quantifies the difference between the control group and the treatment group. Positive effect size in the treatment group suggests that CAI is effective. The findings indicated a positive effect size of 0.14, i.e. around 50% of the treatment group did better than the control group. *Read, Write & Type* and *Phoneme*

Sequence Programmes had the most significant effect size 0.32 or 62% of the treatment group improved when compared to the control group. Cheung and Slavin (2013) attributed the effect size or the difference between the two groups to the incorporation of small groups into the reading intervention.

These findings are consistent with other meta-analyses of reading interventions. Archer et al. (2014) conducted a tertiary meta-analytic review on earlier meta-analyses of CAI programmes on literacy. In this study, the researchers used the variables of programme training intensity, implementation fidelity, and classroom teacher or researcher delivered instruction. Depending on the level of training and support in implementing the CAI programme, the effect size was small (0.18) to medium (0.57) (54% to 70% of the treatment group improved).

Research on CAI's effectiveness on early literacy skills development is inconclusive. Some researchers (Macaruso & Rodman, 2011b; Macaruso & Walker, 2008b; Ozen et al., 2017) have shown that CAI is effective at increasing pre-school and kindergarten students' phonological awareness and letter knowledge. On the other hand, Ness's (2013) and Kreskey and Truscott's (2016) studies did not reveal any improvements when using CAI. Research using the same programme can have different results as well. Huffstetter et al. (2010) and Kreskey and Truscott (2016) both examined *Headsprout Early Reading* and had different conclusions on its effectiveness.

In summary, the research indicates that blended learning can be easily implemented into an elementary classroom through station rotation, and there is evidence to support CAI as an educational intervention. However, in order for a CAI programme to be successfully implemented as part of a blended learning classroom, the teachers need to be trained and have positive attitudes towards that programme.

2.6.1 CAI Decoding Research

The foundation of reading skills (in alphabetic languages like English) is alphabetic knowledge. Letter names and letter sounds are the targets of many kindergarten interventions. One method of teaching letter names and letter sounds is through drill procedures. *Tutoring Buddy* teaches letter-sound correspondence by presenting stimuli in a continuous string of letters. DuBois, Volpe, and Hemphill (2014) examined the effectiveness of *Tutoring Buddy* with 30 kindergartners and first graders over a two-week treatment period. Despite a short treatment period, the treatment group doubled their LNF and LSF score. The researchers did the posttest one week after the treatment period to measure maintenance, but this period is not long enough to determine if the effects were sustainable. The researchers concluded that *Tutoring Buddy* was an effective intervention for boosting students' letter name and letter sound knowledge.

An older study conducted by Wild (2009) on CAI support of phonological skills involved 127 children aged five to six in the United Kingdom. The participants separated into a computer group, a paper group, and a control group. This study focused on the *Rhyme and Analogy* programme. The children were read a *Story Rhyme* book and asked to work on related phonological exercises. After a 12-week treatment session, the results indicated that the computer group had greater gains pretest to posttest than the paper group and the control group. On the Phonogolocial Assessment Battery, the treatment group had an 18 point gain while the paper group had a 9.5 point gain, and the control group had a 10 point gain. CAI is not limited to computer programmes since some CAI programmes are designed for iPad or tablet use. Musti-Rao, Lo, and Plati (2015) examined the effects of using *The Sight Words: Kids Learn App*, an educational iPad app, on sight word fluency and oral reading fluency on six kindergartners. The results indicated that the programme did have a positive effect on sight words but no effect on oral reading fluency. The students used the programme for 10 minutes a day for 12 weeks. The results from the study support the use of educational apps, but the participant numbers were minimal, and there was no control group.

Huffstetter et al. (2010) examined *Headsprout Early Reading* and its effect on oral language and reading skills in preschool students. *Headsprout Early Reading* is a CAI programme designed to provide instruction in phonemic awareness, fluency, and vocabulary. Sixty-two participants used *Headsprout Early Reading* for 30 minutes every day for eight weeks. They used the first 40 episodes or lessons of the programme. The online lessons taught phonics, phonemic awareness and vocabulary through explicit instruction. In addition to the lesson, the students read 30 stories for additional practice. The implementation of integrity was graded for a mean of 77%. The results indicated that the students in the treatment group made significant gains in decoding skills. They also improved their oral skills. Huffstetter et al. (2010) commented that the relation between oral and reading skills was visible in this study. The students in the intervention group had higher scores in oral language, and there was a positive correlation between reading and oral skills.

A more recent study on *Headsprout* by Kreskey and Truscott's (2016) suggested that kindergartners who received CAI did not significantly perform better in reading than the students who did not participate in CAI. Their sample size was robust with nine schools in the Southeastern United States participating and 393 kindergartners qualifying as at risk for reading failure. The treatment group pretest to posttest had a 31 point gain in LNF while the control group had a 36 point gain. The results indicated that *Headsprout* did not provide any benefits to phonemic awareness.

Kreskey and Truscott (2016) provided several explanations regarding the lack of improvement in the treatment groups, early literacy skills when using *Headsprout*. First, they suggested that the group using *Headsprout* did not follow the suggested reading intervention requirements of being individualised to each student, occurring several times a week for 15 minutes and lasting several months. Second, the reading curriculum implemented by the school system had a robust phonics approach, which may have lessened the impact of *Headsprout*. Lastly, Kreskey and Truscott (2016) pointed out that previous CAI research cites

student engagement as one reason for success. However, today, many children have access to engaging video games and electronic devices. Thus, CAI may not be as engaging as generally assumed, and even well designed CAI programmes may not be engaging enough to motivate students. Macaruso & Rodman (2011a) mentions the importance of teacher oversight to monitor programme usage, suggesting that CAI programmes are not able to engage students continually without teacher oversight.

2.6.2 CAI Language Research

Most CAI reading programmes are all-encompassing with activities focusing on the different reading components of phonics, phonemic awareness, fluency, and vocabulary. Some programmes teach the phonics and phonemic awareness basics through reading stories and songs. One example of a programme that uses songs and stories is *Starfall,* an online programme designed to increase reading skills through reading stories, songs, and engaging activities. Children enjoy using this programme because the learning activities are interactive. *Starfall* was first designed as a reading programme, but it now covers math concepts as well. The activities are intuitive, and students can work at their own pace without a teacher or parent assistance. *Starfall's* programme allows free-exploration of activities that fit students' needs and interests. A study conducted for *Starfall* by Metis Associates (2014) on 431 kindergartners concluded that the students using *Starfall* achieved significantly higher scores than students who did not use it.

Most CAI programmes do not teach vocabulary as a stand-alone product because as research (McKeown & Beck 2014; Zucker et al., 2013) indicates that students learn vocabulary quicker when they learn it in at least one context if not multiple contexts. As previously discussed, young children gain new vocabulary by being read stories. Thus, excellent computer-based or app-based vocabulary programmes need to teach vocabulary in context.

iPads and tablets provide opportunities for literacy through digital, interactive books. Unlike a computer, the tablet can move with the student around the room like a book. One advantage of digital texts is that they can support comprehension and engage struggling readers (Hutchison, Beschorner, Schmidt-Crawford, 2012). Additionally, one can download numerous books that allow students to read with audio support and text tracking. Tablets and iPads may support and enhance literacy instruction through the use of books and instructional apps (Hutchison, Beschorner, Schmidt-Crawford, 2012).

Toole and Kannass (2018) investigated how 100 four-year-olds in the United States learned new vocabulary when using tablet e-books. The participants were divided into three groups: story content from a traditional print book read by an adult, story content from a tablet read by an adult, and story content read by a device. The results indicated the children learned more words from the eBook and audio read by a device than from an adult reading from a traditional print book. However, the results could be influenced by the pre-schoolers' engagement and excitement about using technology.

A similar study (Msindwana, 2017) was conducted in South Africa with 65 first-grade isiXhosa speaking students. The students were provided with e-books that contained 15 target words. The students listened to the story while looking at the pictures, and then they completed interactive activities based on the story content to promote student interaction with the target words. The results showed that the e-book facilitated the learning of new words as well as retaining the previously learned vocabulary.

Researchers Gremmen, Molenaar and Teepe (2016) and Teepe, Molenaar, and Verhoeven (2017) also examined using technology-enhanced storytelling and multimedia picture stories to increase vocabulary in 3 to 4 year-olds. In both studies, the results indicated an increase in parent-interactions and had a positive effect on receptive and expressive vocabulary knowledge. As previously stated, vocabulary plays a significant role in reading or oral comprehension. Children learn the majority of their vocabulary receptively through conversations or adults

reading to them. In the years before children start school, parents are their vocabulary teachers through the home environment.

In summary, the literature reviewed has indicated that most CAI reading or early literacy programmes combine all aspects of reading from decoding to vocabulary. Also, the research supports CAI use to develop vocabulary by teaching it through the context of stories and songs.

2.7 Lexia Learning Systems products and *Core5*

Lexia Learning Systems was founded in 1984 by Bob Lemire. He started the company because his son was diagnosed with dyslexia, and Lemire wanted to create a product that would help other children with reading difficulties become better readers. Lemire, Dr Cole (a reading specialist), and Dr Littleon Meeks (a technology expert) joined forces to create a technology-based programme to help students with reading difficulties. Since 1984, the developers have created and revised a technology-based programme that provides explicit and personalised reading instructions for students of all abilities. Rosetta Stone purchased Lexia Learning Systems in 2013 (Lexia Learning, n.d.).

Macaruso has led the research on Lexia Learning Systems since 2006. Since then, Macaruso & Walker (2008) have investigated the effect of *Early Reading* and *Primary Reading* (both early Lexia Learning Systems programmes) on kindergarten early literacy skills. In their study, no significant statistical difference in letter names or letter sounds knowledge existed at the pretest or posttest. Oral language concepts (or phonological awareness) were the main area displaying a statistical difference between the control group and the treatment group. However, that difference was slight. The treatment group's mean on a test of 20 was 14.8, while the mean for the control group was 12.8. However, when Macaruso and Walker (2008) compared the at-risk students in the control group and the treatment group, the difference increased to a mean of 16 for the treatment group and a mean of 12.4 for the control group. In this study, the

treatment group started with 38 students, but 12 students were dropped from the study because they did not meet the usage requirements. The major flaw of this study is that one of the posttests did not have a pretest. Thus, it is unclear if the participants in the control group and treatment group had the same baseline scores. Macaruso and Walker (2008) cited the reason for no pretest was that the assessment, Gates-MacGinitie Reading Test, did not have a beginning of the year kindergarten test.

Macaruso and Rodman (2011b) continued the research on *Early Reading* and *Primary Reading*. They found that kindergarten students receiving both CAI and classroom instruction made significantly more improvements in the area of phonological awareness and listening comprehension than students who received only classroom instruction. The 41 students in the treatment group and 38 in the control group came from three elementary schools in Boston, Massachusetts. The study's design criterion was for students to use the programme for 200 minutes. This equals ten 20 minutes sessions. At the end of the study, the students in both groups made similar gains in naming lowercase letters, but the control group made more significant improvements in naming uppercase letters than the treatment group.

One caveat in their study was that three of the treatment groups did not meet the minutes required. They mentioned it was difficult for the teachers to remain consistent in their use of CAI. Since reading interventions should take place at least three times a week for 20 minutes (Hudson et al., 2011), research on the effectiveness of CAI should include a prescribed time. The consistency of implementing an integrated intervention in the classroom schedule would ensure students spent the required minutes for programme fidelity. Perhaps this might display the effects of the programme more clearly.

Macaruso & Rodman, (2011a) extended their first study in 2011 and examined how *Early Reading* and *Primary Reading* benefited English language learners (ELL) kindergarten students from Enis, Texas. The treatment length was forty-five 15-20 minute sessions. The results indicated that the treatment had a

0.36 effect size or 62%. The researchers found the most significant gains to be with phonological awareness and no statistical difference between the control and treatment in print recognition, and phoneme-grapheme correspondence. One difference between this research and Macaruso & Rodman's (2011b) research is that 80% of the participants met the usage requirements. Macaruso & Rodman (2011a) cite teacher commitment to using the programme as the reason this study had better success with meeting usage requirements and adhering to implementation guidelines.

Regan, Berkeley, Hughes, and Kirby's (2014) study focusing on *Lexia Strategies for Older Students* (SOS) revealed some students mastered basic word reading skills by just using SOS, but others needed additional instruction. However, only four students participated in this study, limiting the validity of the data. The small sample size allowed the instructor to monitor the students' progress and provide individualised instruction when a student was not progressing through an activity. Additionally, the instructor also provided praise when students completed activities. The study did not indicate how much additional instruction was given to students, but it does mention that SOS instruction alone did not result in the mastery of basic word reading skills. The four participants were able to master basic word reading skills with 85-100% accuracy because of the combination of SOS and individualised instruction when needed.

Lexia Learning Systems developed *Lexia Reading Core5*® from previous Lexia Learning System products. *Core5* provides sequential instruction in reading skills. Students are placed at a level based on a placement test and then progress through levels as they complete skillsets. This popular programme is used mostly for reading remediation but can be used in elementary grades for an extension. Because of the sequential, individualised instruction and teacher dashboard, *Core5* is a programme that can easily adapt to a blended learning environment.

The first study using *Core5* was conducted with two first grade classes and two-second grade classes in Massachusetts with a treatment period of five months (Schechter et al., 2015). The participant sample size was small but similar in size,

with 45 participants in the treatment group, and 38 participants in the control group. Over three months, 90% of participants met usage goals. However, that percentage dropped to 60% by the time the treatment session ended. The researchers did not explain why there was a drop in usage.

Schechter et al. (2015) found that the treatment group improved in reading comprehension with a moderate 0.52 effect size or 69%. However, no statistical difference existed between the treatment group and the control group in vocabulary. When the data examined only English Language Learners (ELL) students, the effect size strengthened to 0.82 or 79% on total scores. There was also a statistical difference in vocabulary but a small effect size of 0.21 or 58%. Just as Macaruso & Rodman (2011a) mentioned in their study, Schechter et al. (2015) cited proper implementation and teacher engagement as crucial to CAI success. Teachers were responsible for monitoring usage and used the Skills Builders packages and other *Core5* materials as morning seatwork or homework. Thus, it is challenging to determine if the CAI programme or additional worksheets and teacher interaction were responsible for student improvement.

Wilkes et al. (2016) built on the success that ELL students had in the Schechter et al. (2015) study. In this study performed on second-graders in California, 77% of the participants were ELL, and 93% of the participants were socioeconomically disadvantaged. The treatment period lasted for 16 weeks, and all participants met their usage for at least ten weeks. Consistent with Schechter et al. (2015), the participants in the treatment groups made improvements. While this study did not measure the effect size, Wilkes et al. (2016) summarised that the participants in the treatment group made four times the gains than those in the control group.

Kazakoff, Macaruso and Hook (2018) also investigated *Core5* as part of a blended learning environment and compared the reading development of ELL students with non-ELL students. The sample consisted of 442 ELL students and 442 non-ELL students from kindergarten to fifth-grade from 64 schools. The researchers used AIMSweb as the probe. At the beginning of the study, 70% of

the students were below grade level. At the end of the first year, 63% of ELLS and 63% of non-ELLs reached the end of the year *Core5* benchmark. These results suggest that *Core5* improves reading skills for both ELLs and non-ELLs.

Macaruso et al. (2019) conducted a three-year longitudinal study on the reading gains of low socio-economic kindergartners who used *Core5*. In this study, 68 kindergarten students used *Core5* from kindergarten to second grade. Students met minimum programme requirements if they used *Core5* for 20 weeks and met the usage recommendations at least 50% of those weeks. The results showed that students made gains from fall to spring every year, but their reading skills decreased over the summer. While researchers determined *Core5* to be beneficial for low performing students, the study did not have a control group with which to compare scores.

Prescott et al. (2018) examined *Core5* as part of a schoolwide blended learning literacy programme across kindergarten to fifth grade. The researchers investigated the relationship between the progress on *Core5* and gains on a standardised test called GRADE. The results indicated that all the grades except fourth grade made significant growth between pretest and posttest. It also indicated that a total of 26.6% of the variance in the improvement on GRADE was a result of the levels completed in *Core5.* However, this variance was found only in grades kindergarten to second grade. Grades 3-5 did not have as significant growth on GRADE as kindergarten to second grade.

In Baron et al.'s (2019) study, the researchers examined whether *Core5* is an effective method to differentiate instruction in a blended learning environment. Using AIMSweb scores, the researchers divided the 594 third-grade students into four reading categories: poor decoders, typical readers, mixed deficit, and poor comprehenders. The majority of the students were in the mixed deficit and typical reader categories. Based on the pretest-posttest reading fluency scores, the students in the mixed deficit group and the poor decoder group made significant improvements, but the other two groups did not. The results for the reading comprehension pretest-posttest gains indicated that the mixed deficits and poor

comprehenders made gains while the other two groups' scores decreased at the posttest.

Lexia Learning Systems sponsored most of the research on *Core5*, and the results indicated that the programme was effective. However, independent research done in New Zealand with elementary students found no gains when using *Lexia Reading,* an early *Core5* version (Ness et al., 2013). The participants used *Lexia Reading* for 100 minutes a week for ten weeks, and in the end, data indicated no significant difference between the control and treatment groups. However, in the category of word reading, the control group made more progress than the treatment group. While this study did not mention how *Lexia Reading* was implemented in the classroom, Schechter et al. (2015) cite the lack of using the additional resources and lack of teacher support as the reasons why there were no significant gains.

Another independently researched study by McMurray (2013), conducted in Ireland, found that when using *Lexia Reading* with year 3 (six to seven-year-olds) students with significant learning difficulties, 66% of students increased their reading score. The mean posttest score increased from 87 to 93, while the control group only increased from 88 to 89. McMurray (2013) specifies the number of students in each treatment but fails to mention how many were in the control group. Additionally, the study states that the treatment lasted 20 weeks but does not mention how many sessions or minutes in the programme students expected to complete. Neither does it mention if students met the 75% usage minutes recommend by Lexia.

One aspect of this study that differed from other studies was the qualitative research on teacher and student attitudes toward *Lexia Reading*. McMurray (2013) interviewed teachers and their students on their impressions of *Lexia Reading*. Over 80% of the participants, using *Lexia Reading* said they liked using it. All the teachers thought *Lexia Reading* was beneficial for their students and wanted to continue using it in their class. One negative the teachers cited for the programme was that students had to repeat activities and got 'stuck' on a level. They also

mentioned the difficulties in monitoring student usage. While most of the teachers did not use the supplemental materials provided to help students who were ‘stuck,' they thought they were well designed and useful. Lack of time was the reason cited for not using those materials.

O’Callaghan et al. (2016) is the only independent research on the current *Core5* version. O’Callaghan et al. (2016) expanded on McMurray’s (2013) research and studied the impact of *Core5* on four to six-year-old students in Northern Ireland. Over an eight-week block, 49 students had daily access to *Core5* for 20-30 minutes. While there were greater gains made by the treatment group than the control group, the effect sizes were small. In blending, the effect size was small at 0.36, and in nonsense words (words that follow phonetic rules but have no meaning), it was also small at 0.35. While the majority of the participants in the treatment group made significant progress, 35% failed to make any progress in blending and nonsense words. O'Callaghan et al. (2016) mentioned the need for multimodal literacy interventions that are guided by skilled instructors who monitor student progress and provide additional instruction.

Core5 is a quality computer-based early literacy intervention. The programme does include the components of decoding and vocabulary essential to literacy development. However, the studies conducted using *Core5* and other Lexia Learning System products have mixed results. The study with the best results contained teachers who were excited about using the programme. Thus, a comprehensive evaluation of *Core5* is necessary to better inform decision-makers on the effectiveness of *Core5* and practices that make the most difference in its implementation.

2.8 Conclusion

This literature review provides evidence that reading interventions aimed at developing early literacy skills must address both decoding and oral language deficiencies. Interventions need to occur for about 20 minutes three to five times a

week. Computer-aided instructional programmes can be effective if implemented correctly. In particular, *Core5* is a CAI product that claims to improve early literacy skills, but the company has funded most of the research. With any programme, teacher attitudes and implementation of product directly affect the efficacy of the product.

3 Methodology

3.1 Introduction

The purpose of this study was to evaluate the impact of *Lexia Reading Core5*® on the early literacy development of kindergartners in the Matanuska Susitna Borough School District in Alaska. As detailed in the literature review, the research on CAI's effectiveness is varied. Researchers (Macaruso & Rodman, 2011b; Ozen et al., 2017) previously demonstrated that CAI is effective at increasing pre-school and kindergarten students' phonological awareness and letter knowledge.

On the other hand, Ness (2013) and Kreskey and Truscott's (2016) studies did not detect any improvements when using CAI. Lexia Learning Systems Company has sponsored the majority of the research on *Core5*. Researchers Schechter et al. (2015) and Wilkes et al. (2016) both found evidence to support the claim that *Core5* does improve the literacy development of students.

The research questions of this study examine the *Core5's* effectiveness in supporting the two components—decoding and comprehension—of the *simple view of reading*. This study was conducted through the positivist research paradigm. Thus, since the epistemology of this design is that reality can be measured, the methods used are quantitative.

This chapter presents the research paradigm and research design, followed by a description of the research questions along with the null and alternative hypotheses. The population for this study, as well as the sampling procedures, are also described. Next, this chapter defines the probes and procedures used to collect the data. Then, it reviews the implementation of *Core5* in the classroom as well as the factors used to determine if the programme was implemented with fidelity. Finally, this chapter reviews the ethical considerations and precautions taken to safeguard the participants.

3.2 Research Paradigm

The research paradigm is a set of assumptions about reality shared by the research community. These assumptions provide a framework through which to understand the natural world (Aliyu et al., 2014). Researchers use this framework to guide their approach when determining whether their research is quantitative, qualitative or mixed methods.

This study was conducted through the positivist research paradigm. The positivist research paradigm is based on the experimental approach. The ontology of the positivist paradigm is based on objectivity and that there is only one reality. The epistemology of the positivist research paradigm states that the findings of the research are accurate, and knowledge is viewed through the laws of nature (Aliyu et al., 2014; Creswell, 2014). Since the epistemology of this design is that reality can be measured through the laws of nature, the methodology used is quantitative.

3.3 Research Design

The research design of this study is a quantitative quasi-experimental non-equivalent control group pretest-posttest design. The definition of a quantitative quasi-experimental non-equivalent control group pretest-posttest design is: “a dependent variable is measured in one group of participants before (pretest), and after (posttest) a treatment and that same dependent variable is also measured at pretest and posttest in another non-equivalent control group that does not receive the treatment” (SAGE, 2019). One benefit of using this research design is that it minimises the problem of having two comparable groups, which would require the control group and the treatment group to be randomly assigned. The advantage of this design is the ability to compare the scores of two non-equivalent groups when randomisation is not an option. One limitation of this design is the inability to control for selection differences or the differences between the three groups used in the study. Those selection differences could be the driving force behind the

variances observed between the two groups. Thus, this research design can only indicate that the treatment is related to the variances between the groups and is not the cause of the variances (SAGE, 2019).

Several factors led to using a quantitative quasi-experimental non-equivalent group research design. The first purpose of this research is to evaluate *Core5* through the lens of improving decoding, vocabulary, and comprehension skills of kindergartners when compared to kindergartners, who did not receive *Core5*. Thus, the evaluation requires comparing pretest and posttest scores in order to determine the effectiveness of *Core5*, and the only way to determine "strong" improvement in this group is through the analysis of numerical data. The data was collected from kindergartners who received *Core5* intervention and from those who received no *Core5* intervention. Since the kindergartners were not assigned randomly to the treatment group or the control group, the study was a quasi-experimental non-equivalent research design. Because this research was not a true experimental study, the pretest-posttest gains cannot be explicitly attributed to *Core5*. However, a pretest-posttest improvement could demonstrate the effectiveness of *Core5*.

3.4 Role of the Researcher

My role as the researcher was limited to compiling data. I did not provide instruction to teachers on how to implement *Core5,* nor did I conduct observations of classrooms to see how well *Core5* was being implemented. Because I work for the Matanuska Susitna Borough School District as an ELL case manager, I was able to access the myLexia dashboard and use that data to determine the participants for the treatment group, the partial treatment group, and the control group. My job did not interfere with my role as a researcher since I did not teach a kindergarten class.

3.5 Research Questions and Hypotheses

This study aimed to evaluate *Core5* on kindergarten early literacy development. Four research questions were addressed in this study.

The primary research questions and the associated null and alternative hypotheses are listed below.

RQ_1. Is there a statistically significant difference in the decoding skills (letter name fluency and letter sound fluency)) of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

$H_{1,0}$. There is no statistically significant difference in the decoding skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

$H_{1,A}$. There is a statistically significant difference in the decoding skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

RQ_2. Is there a statistically significant difference in the vocabulary and comprehension skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

$H_{2,0}$. There is no statistically significant difference in the vocabulary and comprehension of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

$H_{2,A}$. There is a statistically significant difference in the vocabulary and comprehension of kindergarten students meeting the *Lexia Reading*

Core5® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

The secondary research questions are:

RQ3. What is the correlation between completing all kindergarten *Lexia Reading Core5*® levels and meeting end-of-year benchmarks?

RQ4. What perceptions do teachers have regarding *Lexia Reading Core5®?*

3.6 Participants

This study used convenience sampling to answer the primary research questions instead of probability sampling since many schools in MSBSD already use *Core5.* This sampling is consistent with non-equivalent group pretest-posttest design since one set of kindergartners used *Core5* (or the treatment) consistently, one group used *Core5* inconsistently, and the other group did not use *Core5* at all.

The target population for this study sample was taken from 15 schools in the Matanuska Susitna Borough School District. The sample group consisted of 751 kindergartners, aged 5-6-year-old.

There were 542 participants for the treatment group. They were selected based on three criteria:

1.) They were kindergartners at a Matanuska Susitna Borough School District school.
2.) They used *Core5* (the treatment) for at least 20 weeks and met the weekly recommended minutes for at least ten weeks.
3.) They had scores on all three probes for the pretest and the posttest.

In the partial treatment group, there were 53 kindergarten students. They were selected based on three criteria:

1.) They were kindergartners at a Matanuska Susitna Borough School District school.
2.) They used *Core5* (the treatment) for 50% or less of the recommended usage time.
3.) They had scores on all three probes for the pretest and the posttest.

There were 156 students in the non-equivalent control group. They were selected based on three criteria:

1.) They were kindergartners at a Matanuska Susitna Borough School District school.
2.) They never used *Core5* (the treatment).
3.) They had scores on all three probes for the pretest and the posttest.

Of the approximately 1700 kindergartners in the Matanuska Susitna Borough School District, about 700 did not have pre- or posttest scores on one or more of the three probes. Thus, these kindergartners were excluded from the sample population.

Of the 20 elementary schools in MSBSD, only ten schools used *Core5* consistently during the 2019 school year. Five schools did not use *Core5* as part of the kindergarten curriculum. Of those five schools, two of those schools did not administer one or any of the pretest-posttest probes. The remaining five schools used *Core5* inconsistently (kindergartners did not meet recommended usage). However, four of these schools did not use the same probes or did not save the data they collected.

Of the schools that used *Core5* consistently, half of them were Title 1 schools meaning they received federal funding for Title 1 students or low-income students in order to meet their educational needs. In the treatment group, 328 participants attended a Title 1 school, and all the participants in the partial treatment and control group attended a Title 1 school.

Of the 751 participants, 542 were in the treatment group. In the treatment group, 13% were Alaska Native and American Indian; 8% identified as multi-

ethnic; less than 4% were Asian, Black, Hispanic or Pacific Islander; and 74% were Caucasian. The diversity in the partial treatment group and control group was similar to the treatment group. The control group had the most significant percentage of Alaska Native and American Indian groups at 17% when compared to the other two groups. The control group also had the smallest percentage of white participants at 72.4% when compared to the other two groups. Table 3.1 provides the complete ethnic breakdown for each group.

Table 3.1: Ethnic breakdown of participants

Complete Treatment			Partial Treatment		Control		Total Numbers	Total percentage
Ethnicity	Number	Percent	Number	Percent	Number	Percent		
Alaska Native	57	10.5	4	7.5	21	13.5	82	10.9
American Indian	14	2.6	0	0	5	3.2	19	2.5
Asian	5	.9	0	0	1	.6	6	.8
Black	4	.7	3	5.7	1	.6	8	1.1
Hawaii/Pacific islander	10	1.8	1	1.9	1	.6	12	1.6
Hispanic/Latin	7	1.3	1	1	2	1.3	10	1.3
Multi-ethnic	43	8.3	4	7.5	12	7.7	59	7.9
Caucasian	402	73.9	40	75.5	113	72.4	555	73.9
Totals	542	100	53	100	156	100	751	100

As presented in Table 3.2, in the treatment group, there were 268 (49.3%) females and 274 (50.7%) males; in the partial treatment group, there were 23 (44%) males and 30 (56%) females; and in the control group, there were 82 (52.6 %) females and 74 (47.4%) males. Fourteen kindergartners were identified as English Language Learners (ELL): seven in the treatment group, two in the partial treatment, and five in the control group. There were no kindergartners identified as homeless in the control group or the partial treatment; however, there were eight homeless kindergartners in the treatment group. The treatment group also had 30

students identified as migrants, while the control group had 16 migrant students. The partial treatment group only had one migrant student.

Table 3.2: Gender, ELL, homeless, and migrant breakdown

		Treatment	Partial Treatment	Control	Total	Percentage
Gender	Males	275	23	74	372	50.5
	Females	267	30	82	379	49.5
ELL		7	2	5	14	1.9
Homeless		8	0	0	8	1
Migrant		30	1	16	47	6.3
Special Ed.		53	7	28	88	11.7

The sample population also included 16 kindergarten teachers. While 60 teachers were contacted, only 16 answered the survey. All the teachers who responded to the questionnaire were female. Fifty per cent of the teachers have taught for 11 or more years. Of the other half, six teachers have taught for six to ten years, and the final two teachers have been teaching less than five years.

3.7 Sampling Strategy

Sampling refers to collecting data from a smaller, specific population and using the information gained from that group to generalise interpretations to the entire population (Salkind, 2017). The two main types of sampling methods fall under probability methods and non-probability methods. Probability sampling is any sampling where the selection process is random. The main types of probability methods are simple random sampling, stratified sampling, cluster sampling, and systematic random sampling (Salking, 2017). The main reason to use probability methods is that the sample selected is usually an accurate representation of the general population.

Non-probability sampling method or convenience sampling does not involve random selection. In this type of sampling, the participants are chosen based on

their availability and convenience (Creswell, 2014). The main benefits of non-probability sampling are that it is easy to conduct, it is cheaper than probability sampling, and it is time effective. Often in convenience sampling, the participants are selected based on the shared traits related to the study's objectives.

The current study uses convenience sampling because random sampling was impossible to conduct due to many schools already using *Core5*. The participants were selected based on their grade (kindergarten), their *Core5* usage, and scores on the three probes used to assess growth.

3.8 Data Collection Instruments

The instruments used to collect data in a study are chosen based on the research questions and purpose of that particular study. In quantitative research, the data collection is about numbers or attributes that can be quantified (Zacharias, 2012). Two common forms of data collection are questionnaires or surveys, and physical evidence using an assessment (Zacharias, 2012). In this study, data collected from three assessments and *Core5* answered the first three research questions. An online Likert-scale questionnaire was used as an instrument to collect data from the teachers. The online questionnaire was used because of the time-saving advantages online questionnaires provide.

Questionnaires are often instruments used to collect data. Quantitative research questionnaires usually have a checklist or rating type questions. Questionnaires can be either a printed hard copy or an online version. Using online questionnaires saves the research from having to travel to each participant or from having to spend money on a mailing. Another advantage to online questionnaires is that the participants can answer the questionnaire whenever they have free time. However, one disadvantage to online questionnaires is a lack of participation, incorrect completion, or delayed submission of the questionnaire (Zacharias, 2012).

3.9 Data Collection

Approval was obtained from Matanuska Susitna Borough School District before the data was collected. The data for this research came from the AIMSweb and the MAP K-2 Early Literacy online databases. Teachers administered both AIMSweb and MAP K-2 Early Literacy assessments and the data from each measure was stored on the perspective measures online database. MSBSD provided online access to the raw data from AIMSweb and MAP K-2 Early Literacy for the whole school district. The fall and spring data was collected from the AIMSweb and MAP K-2 Early Literacy online database and then compiled the data together. The data of the students that met the criteria for inclusion in this study were then compiled into a password protected Excel spreadsheet. That data was then imported into Statistical Package for Social Sciences (SPSS), a statistical processing software, to be analysed. Although the raw data did include student names and identification numbers, those names and ID numbers were not included in the Excel spreadsheet or SPSS data files.

The data on *Core5* usage and levels gained came through the myLexia dashboard. This dashboard had a report that compiled all the levels gained, weeks used, and recommended minutes for each student. When the treatment period finished, the data from this report from myLexia was compiled along with the data from AIMSweb and MAP K-2 Early Literacy scores into one spreadsheet.

Likert-scale questionnaires collected data from kindergarten teachers in MSBSD. These questionnaires were sent electronically via email to teachers at the end of the school year. Google Forms were used to create and compile the teachers' responses.

3.10 Measures

The three measures used by the Matanuska Susitna Borough School District to track progress and collect data are AIMSweb Letter Name Fluency, AIMSweb Letter Sound Fluency, and Primary MAP. These probes are

administered three times a year: in fall, winter, and spring. This study used the data collected through AIMSweb and MAP K-2 Early Literacy probes from the fall and the spring.

AIMSweb is a benchmark and progress monitoring system that provides Curriculum-Based Measurement (CBM) assessments to collect data on students' acquisition of reading skills. CBM is the most popular method of benchmarking and progress monitoring in the elementary setting (Review of K-12 Literacy and Math Progress Monitoring Tools, 2013) because CBM uses tests that measure identical skills. AIMSweb is a benchmark assessment routinely administered three times a year: fall, winter, and spring. Its purpose is to assess how well a student is progressing towards literacy goals. It is a benchmark assessment used by the MSBSD to determine growth in reading fluency. In kindergarten, it determines letter name fluency and letter sound fluency; both are predictors of future reading success.

The AIMSweb kindergarten test consists of three subsets: Letter Name Fluency, Letter Sound Fluency, and Numerical Fluency. However, for this study, only the first two subsets are relevant. Letter Naming Fluency (LNF) assesses a student's ability to recognise and name the letters of the alphabet. The letters are presented randomly in upper and lower case forms. The number of correct letters named in a minute is the score for this first test. Letter Sound Fluency (LSF) assesses a student's ability to recognise the letters of the alphabet and say the sounds they represent. Once again, the students are presented with random upper and lower case letters and have one minute to identify as many sounds as they can. This test is an indicator of phonemic awareness. The goals for LNF and LSF increase throughout the school year. Table 3.3 lists the benchmark goals for each assessment period.

Table 3.3: AIMSweb benchmark goals

Time of year	Letter Name Fluency	Letter Sound Fluency
Fall	13 Names	2 Sounds
Winter	38 Names	20 Sounds
Spring	46 Names	33 Sounds

MAP K-2 Early Literacy Test is a computer-adaptive assessment administered at the beginning and end of the study. MAP K-2 Early Literacy assessments produce data that targets the learning level of a student (NWEA, 2014). This assessment is aligned with Common Core State Standards and measures growth from K to 12. MAP K-2 Early Literacy is adaptive and adjusts to the performance of individual students, thus measuring the precise level of that student (NWEA, 2014). Computer-adaptive assessments measure students' abilities by modifying the test questions to the skill level of the student. If a student misses a question, then the following question will be less complicated. If a student gets a question correct, the next question will be more difficult. This adaptive test has 40 questions that cover the skills of phonological awareness, concepts of print and phonics. Of those three primary skills, sub-skills include activities like rhyming words, matching sounds to letters, and orientation to the page.

MAP K-2 Early Literacy uses the RIT scale (Rasch Unit) to describe the level of the student. Northwest Evaluation Association (NWEA) created the RIT scale, and each test item has a single RIT value associated with it. The correct responses to test items generates the final RIT score for the student. The student's RIT score represents the level of test items the student was able to answer correctly 50% of the time. Since the RIT score increases throughout the grades, it is easy to track student growth within a school year, and across several school years (NWEA, 2014). The following table lists the benchmark scores for MAP K-2 Early Literacy at each assessment period.

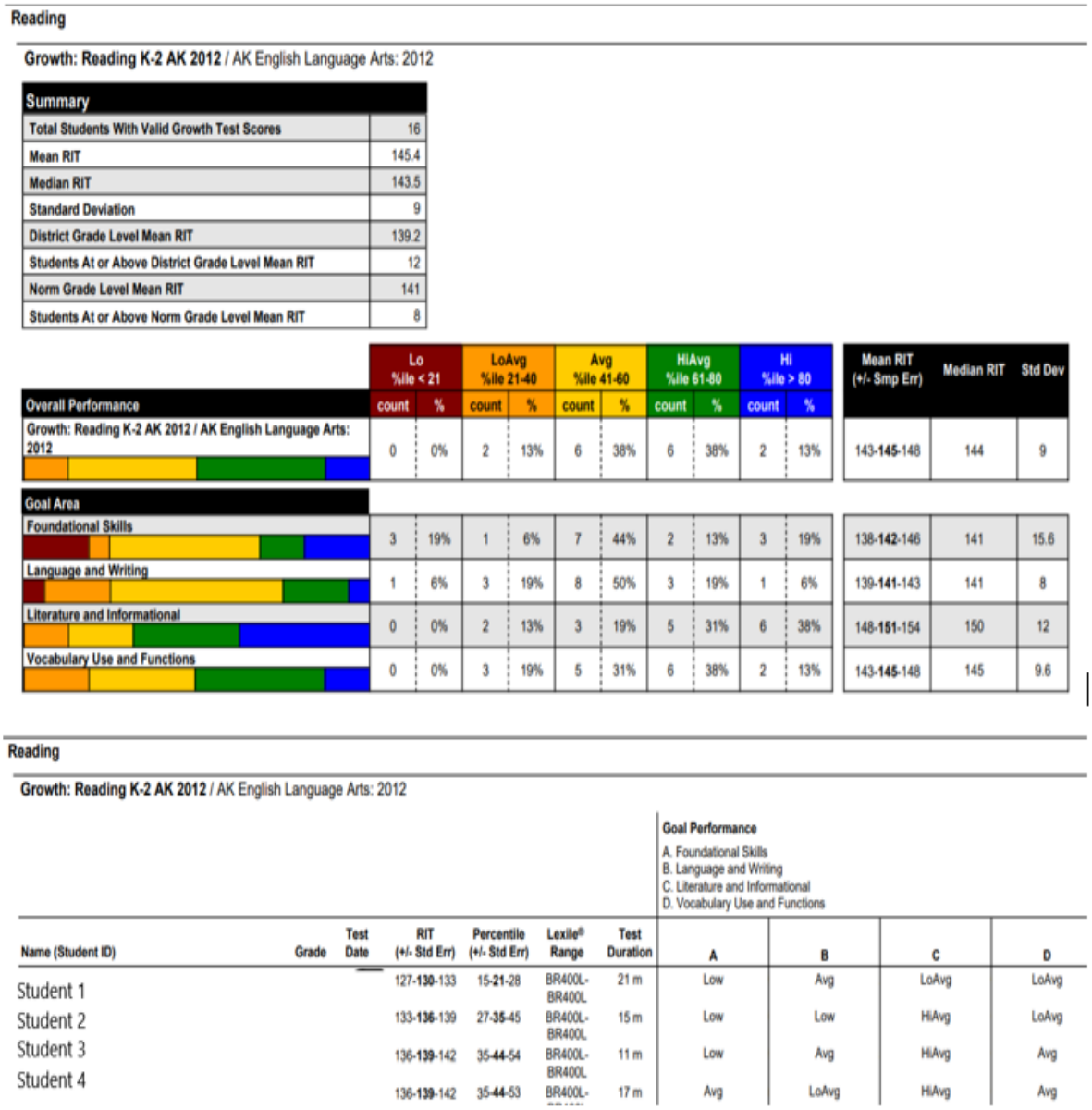
Table 3.4: MAP K-2 Early Literacy benchmark goals

Time of year	RIT Kindergarten Status Norms
Fall	141
Winter	151
Spring	158

MAP K-2 Early Literacy provides RIT scores norms (as seen in Table 3.4) for each grade, and the beginning, middle and end of the year. The RIT scores norms help educators determine a student's proficiency in regards to the benchmark norms. The MAP, K-2 Early Literacy reports, provide an overall picture of the strengths of the entire class (note the top part of Figure 3.1). The sections of MAP K-2 Early Literacy assessment are foundational skills, literature and informational, vocabulary use and functions, and language and writing. The reports also provide a visual snapshot of the levels of performance throughout the class. This report can help teachers create groups in order to differentiate instruction within the classroom. The MAP K-2 Early Literacy report also provides the individual RIT score and percentile score for each student (note the bottom part of Figure 3.1). The teacher can compare the individual RIT score with the benchmark scores to see if the student is on grade level and has made adequate growth to meet the end-of-year benchmarks.

The data from AIMSweb and MAP K-2 Early Literacy is used by the MSBSD to determine student progress in early literacy skills and if the student meets benchmark goals. It also decides which students need additional support via the RTI processes. District administrators also look at the end-of-year growth of schools to determine which schools need additional help in supporting their students.

Figure 3.1: MAP K-2 Early Literacy class report



Reading

Growth: Reading K-2 AK 2012 / AK English Language Arts: 2012

Summary	
Total Students With Valid Growth Test Scores	16
Mean RIT	145.4
Median RIT	143.5
Standard Deviation	9
District Grade Level Mean RIT	139.2
Students At or Above District Grade Level Mean RIT	12
Norm Grade Level Mean RIT	141
Students At or Above Norm Grade Level Mean RIT	8

	Lo %ile < 21		LoAvg %ile 21-40		Avg %ile 41-60		HiAvg %ile 61-80		Hi %ile > 80		Mean RIT (+/- Smp Err)	Median RIT	Std Dev
Overall Performance	count	%	count	%	count	%	count	%	count	%			
Growth: Reading K-2 AK 2012 / AK English Language Arts: 2012	0	0%	2	13%	6	38%	6	38%	2	13%	143-145-148	144	9
Goal Area													
Foundational Skills	3	19%	1	6%	7	44%	2	13%	3	19%	138-142-146	141	15.6
Language and Writing	1	6%	3	19%	8	50%	3	19%	1	6%	139-141-143	141	8
Literature and Informational	0	0%	2	13%	3	19%	5	31%	6	38%	148-151-154	150	12
Vocabulary Use and Functions	0	0%	3	19%	5	31%	6	38%	2	13%	143-145-148	145	9.6

Reading

Growth: Reading K-2 AK 2012 / AK English Language Arts: 2012

Goal Performance
A. Foundational Skills
B. Language and Writing
C. Literature and Informational
D. Vocabulary Use and Functions

Name (Student ID)	Grade	Test Date	RIT (+/- Std Err)	Percentile (+/- Std Err)	Lexile® Range	Test Duration	A	B	C	D
Student 1			127-130-133	15-21-28	BR400L-BR400L	21 m	Low	Avg	LoAvg	LoAvg
Student 2			133-136-139	27-35-45	BR400L-BR400L	15 m	Low	Low	HiAvg	LoAvg
Student 3			136-139-142	35-44-54	BR400L-BR400L	11 m	Low	Avg	HiAvg	Avg
Student 4			136-139-142	35-44-53	BR400L-	17 m	Avg	LoAvg	HiAvg	Avg

An online questionnaire was emailed to all the kindergarten teachers in the Matanuska Susitna Borough School District in order to measure teacher attitudes towards *Core5* and that data was used to address the fourth research question. The questionnaire consisted of 22 questions. The first 12 questions of the questionnaire focused on teachers' attitudes towards *Core5,* and the next 10

focused on how teachers implemented *Core5*. Two questions were opened ended, and one question multiple answers could be selected. The rest of the questions were on a Likert scale ranging from *strongly disagree* to *strongly agree* for the attitude questions and *never* to *always* for the implementation questions.

3.11 The Treatment: *Core5*

This study evaluated the effectiveness of *Core5* on early literacy kindergarten skills. *Core5* was used as the treatment in the treatment and partial treatment groups. *Core5* is an enhanced version of *Lexia Reading*. While *Lexia Reading* firmly focused on phonological awareness and word attack skills for isolated words, *Core5* provides instruction through six strands: phonological awareness, phonics, structural analysis, fluency, vocabulary, and comprehension (Schechter et al., 2015). Table 3.5 describes the content in each strand. *Core5* is organised into 18 levels, and content aligns with Common Core State Standards. Each level consists of activities designed to address the six strands.

Table 3.5: Summary of *Core5*'s contents (Schechter et al., 2015)

Strand	Content
Phonological awareness	Rhyming, blending and segmenting syllables and sounds, manipulating sounds
Phonics	Upper- and lower-case letters, alphabetising
Structural Analysis	Prefixes, roots, and suffixes; spelling rules; etc.
Automaticity/fluency	Sight words, high-frequency words
Vocabulary	Categorising, adjectives, synonyms, multiple meanings, similes, and metaphors, idioms
Comprehension	Listening comprehension, picturing, signal words, sequencing, compare and contrast

Students complete a placement test, and then *Core5* automatically assigns them a level. Once assigned, the student progresses only by completing all the activities with 90-100% accuracy. When a student misses two questions in an

activity, *Core5* automatically moves them to scaffolded practice. If the student continues to struggle, then the programme delivers targeted instruction to help that student master the reading skill. The programme also puts a red flag next to the student's name on the teacher dashboard so the teacher can also intervene and provide direct instruction using skill-specific materials called Lexia Lessons.

Students can monitor their progress by noting how many units and levels they have completed. When students complete a level, teachers can provide them with Skill Builders, a paper worksheet designed to reinforce what the completed level covers. Teachers can also print certificates to give to students as a motivation tool.

The teacher dashboard allows teachers to see how many minutes and units students have completed. It also alerts teachers to students who are stuck on a reading activity. The dashboard also has performance predictors, which provides a visual reflecting the probability of the student completing all the levels in the grade before the end of the year. Based on the performance predictors, the dashboard also displays the prescribed minutes necessary to improve the student's chance of reaching benchmark status.

3.12 *Core5* implementation

The Matanuska Susitna Borough School District buys bulk licenses for different reading and math interventions, including *Core5*. Then, different schools in the district can buy these licenses at a reduced rate to meet their individual needs. While the MSBSD offers specific interventions, it does not mandate which ones schools must use. Thus, schools are left to decide what programmes they will use and how they will use them.

Lexia Learning (the previous *Core5* version) was initially used as an ELL intervention in MSBSD. It was then added as a reading intervention for all students in 2009. In 2015, *Core5* was introduced in the school district, and a trainer came to the district to provide professional development on how to use all the different

aspects of *Core5*. Most teachers receive training through the school's instructional coach. Also, two staff from the curriculum and instructional department in the district office oversee *Core5* and can answer questions regarding programme implementation or how to read the data. They also monitor usage and remove licenses for students who are not using the programme adequately.

While *Core5* was initially purchased as a reading intervention, a couple of schools decided to pilot it as part of the kindergarten curriculum. After piloting it, they decided to continue using it in kindergarten, and other schools followed suit. Despite *Core5* giving guidelines on best implementation practices, the way each school uses *Core5* varies. Depending on the guidance (or lack of guidance) given by the instructional coach or principal, teachers may also differ in how they use *Core5*. Several factors affect implementation. Access to technology, school schedule, and support staff all influence the ability of the teacher to implement *Core5* with fidelity.

The first hurdle teachers may encounter is teaching students how to get on to *Core5*. This could be such a difficult hurdle that teachers avoid using *Core5*. Most teachers print out log-in name cards for each student to help with logging in. At the beginning of the school year, teachers need to sign almost every student in. As the year progress, some students can do this independently while others need help the whole school year. The issue of logging in students was often exacerbated by the device they were using. In some schools, teachers have to take their students to the computer lab where they have to log each student into the computer, wait for it to load, and then click through several links to access *Core5* on the school district website. Other schools use Chromebooks in the classroom. The Chromebooks have the app on the navigation bar, which make accessing *Core5* easier. However, students still have to log into the Chromebooks and then log-in again into *Core5*. Classrooms with iPads seem to be the easiest to log-in. Students click on the *Core5* app and then log-in. If there are enough iPads in the classroom, the students are assigned iPads and do not have to log out.

One advantage of using CAI as part of a blended learning environment is that the teachers can implement the programme in a way that best fits their physical setting, access to technology or schedule. Blended learning can include rotating stations or visiting the lab (Prescott et al., 2018). In the elementary school setting, the rotating stations are considered a good fit because it builds on the model of different activity centres (Powell et al., 2015). A lab rotation is when all students are on the CAI programme at the same time (Prescott et al., 2018). The teachers in MSBSD using *Core5* use either rotation centres or lab rotations.

Many teachers use *Core5* during 40-minute skills block time with some teachers do centre rotations with *Core5* as one of the centres. Other teachers have the whole class on *Core5* for part of the whole skills block time. The way teachers implement *Core5* often depends on whether there are enough devices for each student. There are pros and cons to both styles of implementation.

Using *Core5* as part of the rotation centres works well if there was a support staff in the room assisting students and monitoring *Core5* usage. The support staff help the student log-in and help the student if he/she becomes stuck with a concept. The support staff also are present to ensure students do not disturb each other or misuse the computer. Having a support staff run the centre frees the teacher to monitor the rest of the centres or provide small group instruction. Students are also able to stay focused because the time on *Core5* is short, but if the rotation is too short, then students are not able to meet the usage requirements.

If there is not a support staff to assist, then using *Core5* as a rotation centre does not work well. The teacher has to spend time getting students on *Core5*, which takes away from assisting other students or providing small group instruction. Once students are on *Core5*, the teacher is usually too busy helping other students to help a student struggling with *Core5*. Once the rotation was over, the teacher once again has to spend the time to log-in the next group of students.

The other *Core5* setup used is the lab rotation or whole class on *Core5* at the same time. Teachers that use the computer lab or share Chromebook carts

use this setup. The teacher takes the whole class to the computer lab or out to the Chromebook cart and has students get a Chromebook. Then the teacher goes around and log-ins all the students that need help, which may take about five minutes. Students are spaced apart so that they can focus on *Core5*, and the teacher walks around helping students whenever they need it.

This setup works very well when the teacher can use the Chromebook cart or computer lab three to four times a week. However, due to lack of technology or to the schedule, many teachers use *Core5* for approximately 30 minutes, twice a week, instead of 20 minutes three times a week. Students may have a hard time staying engaged with *Core5* for that long.

The following table has the breakdown of *Core5* usage by schools.

Table 3.6: *Core5* usage by school

School	Average Number of Weeks Used	Average Number of Weeks Met Usage
School 1	22	20
School 2	30	25
School 3	26	22
School 4	27	17
School 5	28	24
School 6	30	27
School 7	32	29
School 8	29	24
School 9	28	21
School 10	26	20
School 11 Partial use	17	9

3.13 Fidelity of Implementation

The expectation for the fidelity of implementation for the treatment group was that students met the required usage for at least ten weeks and used *Core5* for at least 20 weeks. Most teachers were able to get the students on *Core5* for

close to 30 weeks, with the average being 28 weeks. Additionally, the average number of weeks where students met the recommended minutes was 20 weeks. The expectation for the partial treatment group was that students used *Core5* for a minimum of five weeks. The range of weeks used was from eight weeks to twenty-nine weeks. The number of weeks was the partial treatment group met the required usage ranged from zero to nine weeks.

3.14 Data Analysis

The pretest-posttest data for the treatment group, the partial treatment group, and the control group were collected and analysed using a mixed-subjects analysis of variance (ANOVA). The independent variable was receiving *Core5* usage or not. The dependent variable was the pretest-posttest gains. Bonferroni post hoc was also run to determine the difference between the three groups. Finally, the effect size was calculated using eta squared and Cohen's *d* (Salkind, 2017).

At the end of the treatment session, the data from *Core5* levels were correlated with the probe scores. A Pearson *r* correlation determined the strength and direction of a monotonic relationship between levels of *Core5* completed and increased test scores (Holcomb, 2017). All statistical analysis in this study used the programme IBM SPSS 26. This programme is a statistic software used to execute different statistical tasks. SPSS analyses data in simple steps.

3.15 Research Limitations and Delimitations

Every research will have some limitations beyond the researcher's control (Ellis & Levy, 2009), and this study is no different. The following are some limitations that affect this study.

1. The study used convenience sampling of students instead of random sampling. Since many schools have been using *Core5*, it would have been impossible to have a random sampling of students into the treatment, partial

treatment, and control groups. Because it would have been impossible to use random sampling, this study used the non-equivalent research design. While convenience sampling does have disadvantages, it is common in research where random sampling is not possible (Demerouti & Rispens, 2014). The main disadvantage is that convenience sampling limits the study's external validity, and the results are generalised only to the hypothetical population of similar students.

2. Since the students in the control group attend different schools from those in the treatment group and partial treatment group, the groups were not equivalent. Every school has a different culture, and this can impact pretest-posttest improvements. In other words, it might be that some schools focus more on test scores, while others focus on experimental learning.

3. The way *Core5* was implemented was different at each school, depending on the technology access the teachers had as well as the expectations the principal provided. Additionally, each teacher provided instruction according to their teaching style and experience. Some teachers may be more effective at providing instruction than others.

This study was not a true experiment with randomly assigned participants. Instead, it was based on real-world data and thus could provide information on how *Core5* works in a school environment.

According to Ellis and Levy (2009), research delimitations are aspects of the study that were controlled by the researcher. These decisions about what aspects or features of the study to include or exclude limit the scope of the study. The delimitations of this study were the decision to use only quantitative research and the decision to conduct the study only in Matanuska Susitna Borough School District.

The decision to use quantitative methodology affected the type of data collected. The study focused only on student test scores and not student or teacher experiences with *Core5*. Qualitative data would have provided insight into whether students enjoyed using *Core5*, and if they found it easy or difficult to use. Qualitative data from teachers would have provided data on how easy *Core5* was

to implement in their classroom, what struggles they had with the programme, what their perceptions were on whether students enjoyed using the programme, and how it impacted their students' reading ability. Because the sample size was large, qualitative data was not collected. In qualitative research studies, the sample size is usually smaller. Having a large sample size put a time constraint on conducting interviews. In short, there were not enough resources to interview each participant in this study if collecting qualitative data as part of the research design.

The decision to conduct the study only in MSBSD was based on the availability of the data and proximity of other school districts. The school district granted permission to use their data for this study. The next nearest school district was 80 kilometres away. Unfortunately, this decision led to a lack of diversity in the sample population. The majority of the sample population were Caucasian. If this study had included the Anchorage School District, there might have been more diversity in the sample population.

3.16 Validity and Reliability of the Research

Validity and reliability are concepts used to evaluate research. In this study, validity and reliability are used to determine if the instruments used to collect data measure the intended items. Reliability refers to how consistent a measure is, and validity refers to how accurate a measure is. For a measure to be reliable, it must be consistent, predictable, and accurate across different research projects (Creswell, 2014). For a measure to be valid, the measure must collect the data is set out to collect (Creswell, 2014). Researchers must not assume that the measures they use are valid and reliable, but they should ensure the data collection collects the intended information. The following sections examine the validity and reliability of the data collection measures used in the current study.

3.16.1 Concept of Validity

The research process is valid when the methods used to measure the data actually measure what the methods intended to measure. With a valid measure, the results will correspond to real-world values and can be used to explain real-world situations. There are two types of validity: internal and external. Internal validity refers to “the degree of confidence that the causal relationship being tested is trustworthy and not influenced by other factors or variables” (Streefkerk, 2019, para. 2). External validity refers to how the results apply to different sample populations, situations, or scenarios (Streefkerk, 2019).

In any research, other factors can threaten the internal and external validity of a study. The following is an explanation of the seven possible threats (Streefkerk, 2019) to the internal validity of the current study.

- **Confounding factors**: an unexpected factor influences the causal relationship (*Core5* and early literacy skills) of the study.
    - In the current study, an unexpected factor could be the use of other CAI programmes in addition to *Core5* such as *Imagine Learning* or *MobyMax*; two other commonly used literacy programmes. This information was not requested, and thus it could be an unexpected and unknown factor.
- **Maturation**: The passage of time influences the dependent variable.
    - The treatment period was over the school year. Kindergartners who were engaged and progressing through *Core5* at the beginning of the year may start to become disengaged towards the end of treatment or as the levels become more difficult. The reverse could also happen: kindergartners who struggled to stay engaged at the beginning of the treatment may have developed the needed skills to work through the Core5 lessons actively.
- **Testing**: The pretest affects posttest.

    - This could be an issue for the AIMSweb probes as they are similar. However, the MAP K-2 Literacy probe has different questions, and it is adaptive. Thus, the only benefit kindergartners have at the posttest is knowledgeable on how to navigate through the assessment.
- **Participant selection**: The participants in the different groups differ substantially.
    - This is not a threat to the internal validity in this study. The population is very similar.
- **Mortality**: Participants drop out.
    - Due to the nature of this study, the participants were selected based on having completed the full treatment, partial treatment or no treatment. Thus, this was not a threat to internal validity. However, the three groups of this study were not equal in size, which could affect internal validity.
- **Regression towards mean**: Extreme scores tend to be closer to the average on the second measurement.
    - There was not a regression to the mean.
- **Instrumentation**: There is a change in how the dependent variable is measured.
    - The instruments used were the same at the pretest and the posttest.

The following is an explanation of the two threats to external validity in regards to this study.

- **Testing**: The participants behave differently because they are in a research setting.
    - Since this study used the data collected from ‘real world’ assessments (MSBSD’s assessments), the participants did not interact with the researcher. However, they may have behaved

differently during the assessing period than they did in the classroom setting affecting the outcome of the data.

- **Participant selection:** The sample population differs from the general population.
    - While the sample population is representative of the population in MSBSD, it may not be representative of a more diverse school district.

The measures of AIMSweb and MAP K-2 Literacy used to determine the relationship between *Core5* and kindergartner early literacy skills have gone through rigorous testing by the AIMSweb and MAP K-2 companies to ensure those assessments assess what they intend to assess. Thus, the tests of validity did not need to be applied to those assessments. However, since the survey assesses teachers' perceptions of *Core5*, the tests of validity need to be applied to the survey.

The four main types of test validity are construct validity, content validity, face validity, and criterion validity (Middleton, 2019b).

- **Construct validity**: It evaluates whether the measurement measures what is supposed to be measured. In order to have construct validity, the measures must be developed on relevant knowledge and use relevant questions.
- **Content validity:** This validity test assesses whether the measure is representative of all the relevant parts of the subject it is measuring. If important aspects are left out of the measure, the validity of the measure is threatened.
- **Face validity**: This refers to how suitable the content of a measure is at face value. It is often considered a weak form of validity.
- **Criterion validity:** Criterion validity evaluates the measure with another established measure. To calculate criterion validity, one must compare the results of the created measure with the results of

an established measure. If there is a correlation, then the created measure is valid.

The content validity test determines the validity of the survey in the current study. The question “Does the survey measure the teachers’ perceptions of *Core5*?” needed to be answered to determine the survey’s validity. The statements used in the survey are directly related to *Core5* and relevant to how teachers use it in the classroom. Irrelevant aspects such as teachers’ attitudes towards technology in general or questions regarding beliefs on best early literacy teaching practices were excluded.

In summary, validity was achieved in the current study by using data from demonstrated valid probes to evaluate the causal relationship between *Core5* and kindergarten early literacy skills. It was also achieved in the survey by using statements that directly related to different perceptions teachers may have towards *Core5.* Other researchers could use similar data and methods to recreate similar results to the current study.

3.16.2 Concept of Reliability

The reliability of a measure indicates the extent that the results can be reproduced when used in similar conditions (Creswell, 2014). Reliability is assessed by determining if the results are consistent in different settings, using different observers, and across the different sections of the test (Middleton, 2019a).

The types of reliability (Middleton, 2019a) are:

- **Test-retest**: Are the results the same when the measure is repeated?
- **Interrater:** Are the results the same when different people implement the same assessment?
- **Parallel forms:** Are the results the same between two equivalent versions of a test?

- **Internal consistency**: Are the results the same from different parts of the test that measure the same thing?

Similarly to validity, the AIMSweb and MAP K-2 Literacy probes have undergone multiple tests of reliability to ensure that the results are repeatable no matter who the observer or assessor is. Since MAP K-2 is a computer-based assessment, there should be little to no issues with reliability between different proctors conducting the assessment unless those proctors severely over accommodate. The AIMSweb probes are proctored face-to-face. Thus, there could be some issues with reliability due to different proctors conducting the assessments. For example, a proctor could allow more think time than the allotted three seconds or not follow the script and add words of encouragement and hints. Alternatively, they could incorrectly score a student. All these would affect the reliability of the assessment. However, since the proctors are trained, the rate of issues due to a proctor not following the assessment protocol should be very low.

The survey used to determine the teachers' perceptions of *Core5* was delivered and rated electronically. Thus, there should be no interrater issues with reliability. The results should probably be similar if the survey was repeated with a larger kindergarten teacher population. However, since that was not done, test-retest was not used to determine if the questionnaire was reliable, and neither was parallel forms. The internal consistency of the questionnaire determined if the questionnaire was reliable. The results were similar across all the statements. The statements were designed as both positive and negative statements towards *Core5* to see if there was internal consistency in the results.

In summary, reliability was achieved in the current study by using probes that have shown to be reliable across time and have been consistently used in MSBSD. Reliability was also achieved by ensuring there was internal consistency within the results of the survey.

3.17 Ethical Issues in the Study

The ethical issues for this study were low risk since this study used existing data provided by the school district and did not require teachers to do anything different in their classrooms from what was already expected of them by their principal and the school district. The MSBSD granted permission to use their data and conduct this research. The ethics committee at the University of South Africa (UNISA) also cleared this study, and no data was collected before permission was granted. The main issue was to ensure the anonymity of the participants through careful management of the data. After the data was collected, the students' names were replaced with code numbers to maintain anonymity. All compiled data were stored on a password-protected computer, and the data files were password protected as well. The raw data were stored as part of school records on their online platform.

3.18 Conclusion

The purpose of this study was to evaluate the impact of *Core5* on the early literacy skills of kindergartners. The goal of this study was to provide empirical evidence on *Core5* that can be used by administrators and teachers when considering best practices and usage for *Core5*. This chapter described the population of this study as well as the types of probes used for the pre/posttest. The Matanuska Susitna Borough School District collected the data and provided access to the researcher for this study. That data was then compiled and analysed using ANOVA, Bonferroni's post hoc, and Pearson's correlation. The research design and methodology influenced the scope of this study, and the study's limitations were discussed in this chapter. Finally, ethical issues were addressed.

4 Chapter 4: Data Analysis and Results

4.1 Introduction

The purpose of this study was to evaluate the impact of *Lexia Reading Core5*® on the early literacy development of kindergartners in the Matanuska Susitna Borough School District in Alaska. There were 751 participants divided into three groups. Five hundred forty-two participants in the treatment group used *Core5* for at least 20 weeks at the recommended usage time. One hundred and fifty-six students did not use *Core5,* and 53 students used *Core5* but not for the recommended usage time. The research design used was a quantitative quasi-experimental, non-equivalent control group pretest-posttest design. The treatment period was at least 20 weeks of recommended *Core5* usage. The data came from three probes, AIMSweb Letter Name Fluency, AIMSweb Letter Sound Fluency, and MAP K-2 Early Literacy assessments administered by the school district at the beginning and end of the school year.

This chapter presents the data and the analysis of the data. The analysis of the data provides evidence to support or reject the null hypothesis for each research question. This study aimed to evaluate *Lexia Reading Core5*® on kindergarten literacy. Four research questions were addressed in this study.

The following are the primary research questions and the associated null and alternative hypotheses.

RQ_1. Is there a statistically significant difference in the decoding skills (letter name fluency and letter sound fluency) of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

$H_{1,0}$. There is no statistically significant difference in the decoding skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

$H_{1,A}$. There is a statistically significant difference in the decoding skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

RQ_2. Is there a statistically significant difference in the vocabulary and comprehension skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

$H_{2,0}$. There is no statistically significant difference in the vocabulary and comprehension of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

$H_{2,A}$. There is a statistically significant difference in the vocabulary and comprehension of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

The secondary research questions are:

RQ_3. What is the correlation between completing all kindergarten *Lexia Reading Core5*® levels and meeting end-of-year benchmarks?

RQ_4. What perceptions do teachers have regarding *Lexia Reading Core5*®?

The remainder of this chapter provides an overview of the types of data analysis used. The pretest data is discussed, and then the posttest data is presented with tables and graphs to illustrate the findings. Finally, the hypothesis for each question is discussed in light of the results.

4.2 Descriptions of Analysis Used

A simple or one-way analysis of variance (ANOVA) analysed the pretest-posttest data for the treatment group, the partial treatment group and the control group. The one-way ANOVA was used because there was only one grouping dimension. The ANOVA separates variances due to the differences between groups and within groups, and then the two types of variances are compared (Salkind, 2017). This type of analysis is used when comparing the differences between the means of three or more groups. According to Salkind (2017), the formula used to run an ANOVA is:

$$F = \frac{MSbetween}{MSwithin}$$

Where:

- F is the test statistic used
- $MS_{between}$ is the variance between the groups
- MS_{within} is the variance within the groups

The ANOVA was run with a post hoc. Post hoc is the comparisons of each mean with the other means in order to determine the significant differences between the three groups that contribute to the overall difference in the groups (Salkind, 2017). For this study, Bonferroni post hoc test was used.

To determine the probability that the scores were a result of *Core5* usage and not chance, the *p*-value was set at a stringent level of significance $p < .01$. Thus, because 0.01 was the criterion for the *p*-value, any difference between scores less than 0.01 indicate there is a significant difference between the scores.

One statistical assumption of the ANOVA is that the groups analysed show close to equal variances on the dependent variable. To test the assumption of equal variances, Levene's test of homogeneity of variance was run. As shown in Table 4.1, the homogeneity of variance assumption was met for all three probes

for the pretest (the *p*-value > 0.01). The following table describes F (the ratio of two variances), the degree of freedoms (DF) or the number of values in the statistical calculation, and *p*-value (probability) for each probe.

Table 4.1: Homogeneity of variances for pretest

Pretest	F	DF1	DF2	*p*-value
MAP	1.479	2	748	.228
LNF	1.699	2	748	.184
LSF	1.115	2	748	.328

As shown in Table 4.2, the homogeneity of variance assumption was also met for all three probes for the posttest (the *p*-value > 0.01). The homogeneity of variance assumption was close to being violated for the posttest MAP K-2 Early Literacy probe with $p = 0.019$, but this is still higher than 0.01. Because the homogeneity of variance was equal, the ANOVA run was used as planned, and all the *F* tests were evaluated for significance using $p < 0.01$.

Table 4.2: Homogeneity of variances for posttest

Posttest	F	DF1	DF2	*p*-value
MAP	.741	2	748	.019
LNF	1.688	2	748	.186
LSF	.741	2	748	.477

The effect size is the measure used to determine the magnitude of the treatment (Salkind, 2017). In order to determine the effect size of *Core5* usage, both eta squared (η^2) and Cohen's *d* were used. Eta squared is used to indicate the percentage of variance in the dependent variable while Cohen's *d* indicates how big the difference is between two means. Thus, η^2 efficiently compares the size of the effect within a group, but it does not provide the effect between the different groups (Lakens, 2013).

η^2 was used to determine the effect size based on the ANOVA. The effect size for the ANOVA and all the groups was measured using eta squared or η^2.

The formula for $\eta^{2:}$

$$\eta 2 = \frac{Between - group\ sums\ of\ squares}{Total\ sums\ of\ squares}$$

The following effect size scale for η^2 determined how large of an effect *Core5* had when comparing all three groups.

- Small effect = 0.01
- Medium effect =0.06
- Large effect =0.14

Then Cohen's *d* was used to determine the effect size when there were two groups with significant differences. The formula used to determine the effect size between the two groups is as follows:

$$d = \frac{(mean\ of\ treatment\ group) - (mean\ of\ control\ group)}{Standard\ deviation}$$

The effect size guidelines for Cohen's *d*:

- Small effect = 0.2
- Medium effect =0.5
- Large effect = 0.8 and higher

Pearson *r* was used to determine the correlation between *Core5* levels and scores on the probes. According to Holcomb (2017), Pearson *r* should be used when investigating the relationship between two scale variables. The two variables used in this study were the *Core5* levels and the scores on the probes.

4.3 Analysing Pretest Data

When evaluating an early literacy intervention programme, it is essential to ensure the group receiving the treatment is performing similarly to the control group before the treatment begins otherwise the effect size of the treatment could be skewed. A one-way analysis of variance (ANOVA) of the pretest data ensured the baseline was similar between the three groups.

Most kindergartners begin school with minimal letter sound knowledge. The pretest assessment offers a baseline point and provides a way to assess the growth in all three groups from the fall to the spring. According to Table 4.3, on the LSF pretest data, the three groups had similar means of 4 to 4.6 letter sounds in one minute, and the standard deviation (the number that describes how the numbers are spread from the mean) ranged from 6.5 to 9.

Table 4.3: Pretest AIMSweb Letter Sound Fluency descriptives

Pretest LSF	N	Mean	Std. Deviation
Treatment	542	4.6808	7.983
Partial Treatment	53	4.0189	9.075
Control	156	4.5513	6.517
Total	751	4.6072	7.777

Table 4.4 is the source table for the ANOVA for LSF pretest. The ANOVA indicated that the *p*-value between the groups was 0.836. Thus, there was no statistically significant difference between the three groups.

Table 4.4: Pretest AIMSweb Letter Sound Fluency ANOVA

Pretest LSF	Sums of Squares	DF	Mean Square	F	*p*-value
Between Groups	21.770	2	10.885	.180	.836
Within Groups	45347.351	748	60.625		
Total	45369.121	750			

Children usually know more letter names than letter sounds, and this was evident in the mean scores on the LNF probe (see Table 4.5). The scores ranged

from 11-13 letters in a minute which was much higher than the mean score of 4 letter sounds. The standard deviation was approximately 12 letter names.

Table 4.5: Pretest AIMSweb Letter Name Fluency descriptives

Pretest LNF	N	Mean	Std. Deviation
Treatment	542	13.2232	11.973
Partial Treatment	53	11.3962	10.429
Control	156	12.8590	11.783
Total	751	13.0186	11.826

Table 4.6 is the source table for the ANOVA for LNF pretest. The *p*-value for the LNF group was 0.533. There was no statistically significant difference in the group.

Table 4.6: Pretest AIMSweb Letter Name Fluency ANOVA

Pretest LNF	Sums of Squares	DF	Mean Square	F	*p*-value
Between Groups	166.175	2	83.088	.593	.533
Within Groups	104735.564	748	140.021		
Total	104901.739	750			

The MAP Early Literacy K-2 probe assesses students' vocabulary, comprehension, and foundational reading skills with the benchmark score for the beginning of kindergarten an RIT value of 141. According to Table 4.7, the RIT value means of all three groups were between 139-140. Thus, the mean of the MAP K-2 Early Literacy assessment was close to the benchmark score for the beginning of kindergarten. The standard deviation was similar in all three groups.

Table 4.7: Pretest MAP Early Literacy K-12 descriptives

Pretest MAP	N	Mean	Std. Deviation	Std. Error
Treatment	542	139.7251	8.551	.367
Partial Treatment	53	139.4528	8.511	1.169
Control	156	139.1474	7.669	.614
Total	751	139.5859	8.365	.305

Table 4.8 is the source table for the ANOVA for MAP K-2 Early Literacy pretest. Similarly to LNF and LSF probes, there was no statistically significant difference between the groups because the *p*-value was 0.548.

Table 4.8: Pretest MAP Early Literacy K-2 ANOVA

Pretest MAP	Sums of Squares	DF	Mean Square	F	*p*-value
Between Groups	41.431	2	20.715	.295	.744
Within Groups	52450.780	748	70.121		
Total	52492.210	750			

The results indicated that the three groups had a similar baseline, and there was no significant difference between them. While there was no statistically significant difference between the three groups, there were some interesting differences in the means. The treatment group had the highest means on the LNF, LSF and MAP K-2 Early Literacy probes (Tables 4.3, 4.5, 4.7). This could be a result of the larger sample size in the treatment group. The partial treatment group had the most significant standard deviation at 9.075 on the LSF probes. This suggests that the partial group had a wide range of LSF abilities (Table 4.3).

4.4 Posttest Data Analysis

The pretest probes were completed at the beginning of the 2018-2019 school year, and the posttest probes were administered about one month before

the end of the 2018-2019 school year. The long treatment period provided evidence of students' gains usually accomplished in one school year.

4.5 AIMSWeb data Analysis

The data from the AIMSweb probe determined whether to accept the null hypothesis for the first research question or to reject it.

RQ_1. Is there a statistically significant difference in the decoding skills (letter name fluency and letter sound fluency) of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

$H_{1,0}$. There is no statistically significant difference in the decoding skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

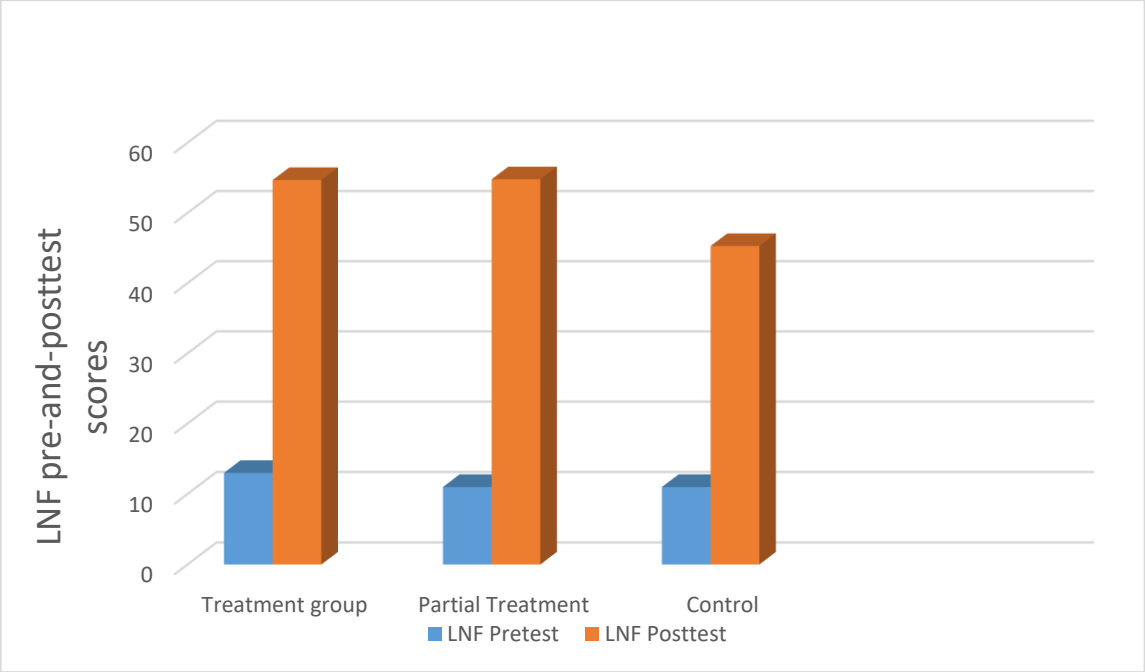
$H_{1,A}$. There is a statistically significant difference in the decoding skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

The above research question investigates the phonological awareness and letter knowledge of the kindergartners. The data from the LNF probe was used to determine if there was a difference in letter knowledge (Figure 4.1). The data from the LSF probe determined if there was a difference in phonological awareness (Table 4.10). As mentioned in the introduction (Table 4.2), a test of homogeneity was run, and the assumptions of homogeneity were not violated indicating the comparison groups had the same variance. Thus, ANOVA was used, and both η^2 and Cohen's *d* were calculated to determine the effect sizes.

4.5.1 AIMSweb LNF data Analysis

On the AIMSweb LNF probe, all three groups made significant gains from pretest to posttest (see Figure 4.1). The posttest scores indicated that the treatment group and the partial treatment group had a mean score of nine letter names more than the control group. The mean for the treatment group was 54.7 letter-names a minute with an 18.6 standard deviation. The mean for the partial treatment group was approximately 54.8 letter-names a minute with a 22 standard deviation. This was greater than the benchmark score of 46 letter-names a minute. The control group mean was just under the benchmark score at approximately 45 letter-names a minute with a standard deviation of 18.

Figure 4.1: Average gains on the AIMSweb LNF probe pretest to posttest



The ANOVA of AIMSweb LNF found that there was a statistically significant difference between the groups, $F(2,748)=15.592$, $p < 0.000$ (see Table 4.9).

Table 4.9: Posttest AIMSweb LNF ANOVA

Posttest LNF	Sums of Squares	DF	Mean Square	F	*p*-value
Between Groups	11018.797	2	5509.398	15.592	.000
Within Groups	264296.540	748	353.338		
Total	229327.260	750			

Bonferroni post hoc determined where the difference lies between groups. Table 4.10 describes Bonferroni post hoc group differences. Between the treatment group and the partial treatment group, the *p*-value = 1.00 and thus not statistically different. The mean difference between the two groups was -0.08. The partial treatment group and the control group had a *p* value=0.005, and this is less than 0.01. Thus, the difference between the control and partial treatment groups is statistically significant. Lastly, the *p*-value =0.000 between the treatment group and the control group indicated there was a statistically significant difference between the two groups. The mean difference between treatment and partial treatment group and the control group is 9.5.

Table 4.10: Bonferroni post hoc multiple comparisons

Group	Group	Mean Difference	Std. Error	*p*-value
Treatment	Partial Treatment	-.08849	2.705	1.000
Partial Treatment	Control	9.5225	2.988	.005
Control	Treatment	9.43401	1.707	.000

The data indicated there was a statistically significant difference between the gains of the treatment group and the partial treatment group and the gains of the control group. Thus, the effect size of the *Core5* usage within the three groups was calculated using η^2.

$$\eta^2 = \frac{11018.797}{275315.337} = .0400$$

According to the scale of effect size for η^2, an effect size of 0.0400 is a small effect size. Thus, 66% of the treatment and partial treatment group made greater gains than the control group. The effect size was calculated using Cohen's *d* to determine the effect size between the treatment group and the control group. According to Cohen's *d* scale of effect size previously discussed*, Core5* usage, when comparing just the treatment and control group, had a moderate effect size of 0.511867, or 69% of the treatment group made greater gains compared to the control.

$$\text{Cohens } d = \frac{(45.307 - 54.741)}{18.43057} = 0.511867$$

While all groups made significant gains from pretest to posttest, the partial treatment group had the most significant gain of 43 letter names a minute. The treatment group had a gain of 41.5 letter names a minute while the control group had the smallest gain of 32 letter names a minute.

4.5.2 AIMSweb LSF Data Analysis

The posttest descriptives of AIMSweb LSF means (see Table 4.11) also indicated a significant difference between the treatment and control groups. The treatment group had a mean of 46.8 letter sounds a minute with a standard deviation of 17.315 while the partial treatment group had a mean of 45 letter sounds a minute with a standard deviation of 19.574. The control group had a mean of 38.9 and a standard deviation of 15.981. The benchmark score for the spring LSF probe was 33 letter sounds a minute. All three groups had a mean higher than the benchmark score.

Table 4.11: Posttest AIMSweb LSF descriptives

Posttest LSF	N	Mean	Std. Deviation
Treatment	542	46.8469	17.315
Partial Treatment	53	45.0000	19.574
Control	156	38.9231	15.981
Total	751	45.0706	17.486

The ANOVA of AIMSweb LSF determined that there was a statistically significant difference between the groups, F(2,748)=12.839, $p< 0.000$. The *p*-value was less than 0.01 on both the ANOVA of AIMSweb LNF and LSF, indicating there was a statistical difference between the three groups. Thus, the null hypothesis*, there is no statistically significant difference in the decoding skills of kindergarten students meeting the Lexia Reading Core5® recommended usage, kindergarten students using Lexia Reading Core5® less than recommended, and kindergarten students not using Lexia Reading Core5®,* was rejected (see Table 4.9 and 4.12).

Table 4.12: Posttest AIMSweb LSF ANOVA

Posttest LSF	Sums of Squares	DF	Mean Square	F	*p*-value
Between Groups	7605.893	2	3802.947	12.830	.000
Within Groups	221721.367	748	296.419		
Total	229327.260	750			

Bonferroni post hoc determined the difference between the three groups. As shown in Table 4.13, the *p*-value = 1.00 with no statistically significant difference between the treatment group and the partial treatment group. The partial treatment group and the control group had a *p* value=0.008 which is less than 0.01. Thus, there was a statistically significant difference between those two groups. Lastly, the *p*-value =0.000 indicated there was a statistically significant difference between the treatment group and the control group.

Table 4.13: Bonferroni Post Hoc multiple comparison

Group	Group	Mean Difference	Std. Error	*p*-value
Treatment	Partial Treatment	1.84686	2.477	1.000
Partial Treatment	Control	6.07692	2.737	.008
Control	Treatment	-7.92379	1.564	.000

The data indicated that the treatment group and the partial treatment group were statistically different from the control group. Next, the effect size of the treatment group was calculated using eta squared or η^2.

$$\eta^2 = \frac{7605.893}{229327.260} = .0300$$

According to the scale of effect size for η^2 noted previously, an effect size of 0.0300 was a small effect size. However, when the effect size was calculated using Cohen's *d* for just the treatment group and the control group, the effect size was moderate at 0.475565 or 69% of the treatment group made more significant gains compared to the control.

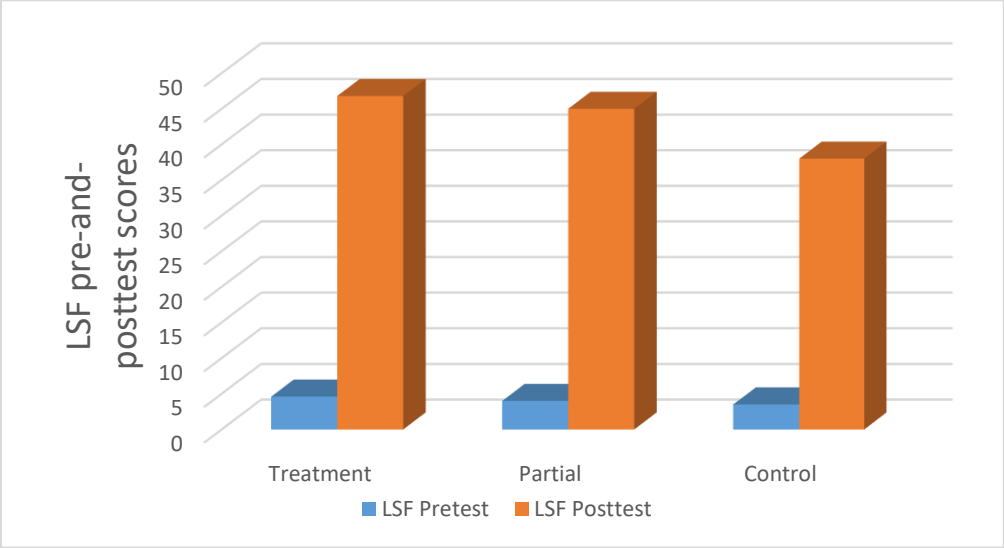
$$\text{Cohens } d = \frac{(38.9231 - 46.8469)}{16.66185} = 0.475565$$

While all groups made significant gains from pretest to posttest on the AIMSweb LSF probe (see Fig. 4.2), the treatment group had the most significant gains with 42 sounds a minute. The partial treatment group had a gain of 41 letter sounds a minute, and the control group had the smallest gains with 34 letter sounds a minute.

An ANOVA and mean descriptive was then run controlling for Title 1 schools. There was no change in the statistically significant difference between the groups. However, the treatment group mean increased from 54 letter-names a minute to 56 letter-names a minute. It also increased from 46 letter-sounds a

minute to 48 letter-sounds a minute. The increase was unexpected because Title 1 schools serve a more economically impoverished community. Children from poor socio-economic backgrounds often struggle more at school than those from better socio-economic backgrounds.

Figure 4.2: Average gains on the AIMSweb LSF probe pretest to posttest



The first research question asked: *Is there a statistically significant difference in the decoding skills (letter name fluency and letter sound fluency) between kindergarten students meeting Core5 recommended usage, kindergarten students using Core5 less than recommended usage, and kindergarten students not using Core5?* The data indicated the answer was "yes." The gains on the LNF and LSF probes were approximately ten letter-sounds or letter-names higher for the kindergartners using *Core5* at the recommended usage and those using it at partial usage when compared to the kindergartners who did not use *Core5*. The *p*-value was 0.000 for both probes, and when the further analysis was done with Bonferroni post hoc, the comparison indicated there was no statistically significant difference between the two groups using *Core5*, but there was a statistically significant difference between the two treatment groups and the control group.

Thus, the null hypothesis of *there is no statistically significant difference between the three groups* was rejected, and the alternative hypothesis of *there is a statistically significant difference between the three groups* in decoding skills was accepted.

4.6 MAP K-2 Reading Data Analysis

The data from the MAP K-2 Early Literacy probe was used to accept or to reject the null hypothesis for the second research question, which addresses the impact *Core5* might have on reading comprehension and vocabulary. MAP K-2 Early Literacy probe is an adaptive test has four sections: foundational skills (decoding skills), literature comprehension, vocabulary, and language and writing. The scores from all four sections are combined into an overall RIT score. The overall RIT score and the sectional RIT scores were analysed to answer research question two.

RQ$_2$. Is there a statistically significant difference in the vocabulary and comprehension skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

H$_{2,0}$. There is no statistically significant difference in the vocabulary and comprehension of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

H$_{2,A}$. There is a statistically significant difference in the vocabulary and comprehension of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®.

Treatment and partial treatment groups had similar means on the MAP K-2 Early Literacy probe. The differences in means are described in Table 4.14. The RIT means for both groups was 158, with a standard deviation of 12.6 and 12.9. The control group had a mean RIT of 156 and a standard deviation of 10. The end-of-year benchmark was a RIT of 158 (see Table 3.4). The treatment group and partial treatment group were right at the end-of-year benchmark goal. The control group was slightly below the benchmark goal. ANOVA was run and $F(2,748)=1.255$, p-value = 0.286 (see Table 4.15). Since $p > 0.01$, the groups are not statistically different.

Table 4.14: Posttest MAP K-2 Early Literacy descriptives

Posttest MAP	N	Mean	Std. Deviation	Std. Error
Treatment	542	158.0978	12.617	.541
Partial Treatment	53	158.1509	12.907	1.77
Control	156	156.3718	10.035	.803
Total	751	157.7430	12.153	.443

Table 4.15: Posttest MAP K-2 Early Literacy ANOVA

Posttest MAP	Sums of Squares	DF	Mean Square	F	*p*-value
Between Groups	370.355	2	185.178	1.255	.286
Within Groups	110407.046	748	147.603		
Total	110777.401	750			

The individual categories were analysed (see Table 4.16). The foundational skills means were statistically different from each other with $p = 0.006$. According to NWEA (2014), the category foundational skills covers skills such as phonological awareness, letter identification, and consonant blends. Those skills are considered decoding skills and not vocabulary or comprehension skills. A post hoc test indicated that the means of the treatment group and the partial group were not statistically different from each other, *p=.619.* The treatment group and partial group were statistically different (at p <. 05), *p=.02, p=.018.* The treatment group did have greater gains in literature comprehension than the other two groups, but

since *p* =0.068 there was no statistically significant difference between the groups. All the three groups had similar scores in the vocabulary, and language and writing categories.

Table 4.16: MAP K-2 Early Literacy categories means and *p*-values

	Foundational Skills		**Literature Comprehension**		**Vocabulary**		**Language and writing**	
	Mean	p-value	Mean	*p*-value	Mean	*p*-value	Mean	*p*-value
Treatment	160.46	.006	158.23	.068	157.79	.974	156.05	.754
Partial Treatment	162.92		156.77		157.32		155.52	
Control	157.07		155.60		157.81		155.10	

An ANOVA and mean descriptive was then run controlling for Title 1 schools. There was no change in the lack of a statistically significant difference between the groups. Also, the means of the three groups remained the same.

The second research questions asked: *Is there a statistically significant difference in the vocabulary and comprehension skills of kindergarten students meeting the Lexia Reading Core5® recommended usage, kindergarten students using Lexia Reading Core5® less than recommended, and kindergarten students not using Lexia Reading Core5®?* The data indicated that the answer to this question was “no”. The gains made from pretest to posttest ranged from 17-18 points between the three groups. An ANOVA of the overall RIT score indicated a *p*-value of 0.286. Thus, there was not a statistically significant difference between the three groups. Analysing the different sections of the MAP K-2 Early Literacy probe indicated there was no statistically significant difference in literature comprehension, vocabulary and language, and writing. Thus, the null hypothesis of *there is no statistically significant difference in vocabulary and comprehension* was accepted, and the alternative hypothesis was rejected.

4.7 *Core5* and Benchmark Correlation

The data from all three probes and the *Lexia Reading Core5*® dashboard were used to answer question three:

RQ3. What is the correlation between completing all kindergarten *Lexia Reading Core5*® levels and meeting end-of-year benchmarks?

This question investigated the relationship between completing *Core5* levels and the end-of-year benchmarks on the probes used by Matanuska Susitna Borough School District. The data from all three probes were compared to the *Core5* level each kindergartner reached using a scattergram and Pearson's *r*.

The following scattergrams for LNF (Figure 4.3), LSF (Figure 4.4), and MAP K-2 Early Literacy (Figure 4.5) assessments indicate a correlation between the *Core5* levels and test scores. The sixth-column of each scattergram represents *Core5* level six, the end-of-year kindergarten level. The blue line indicates the end-of-year benchmark score for the specific probe. Based on the LNF scattergram (see Figure 4.3), more than half of the kindergartners who reached level six also reached the benchmark goal of 46 letter-names per minute. For each *Core5* level past six, the number of kindergartners who did not reach the benchmark goal decreased. A quick inspection of the LSF scattergram (see Figure 4.4) indicated that most kindergartners who reached *Core5* level six also reached the benchmark goal of 33 letter sounds a minute. The scattergram for MAP K-2 Early Literacy scores (see Figure 4.5) indicated approximately half the kindergartners who completed *Core5* level six met the benchmark for MAP K-2 Early Literacy. As the *Core5* level achieved increased, the number of students failing to meet the benchmark score for MAP K-2 Early Literacy decreased.

Figure 4.3: Scattergram of posttest LNF scores and *Core5* levels

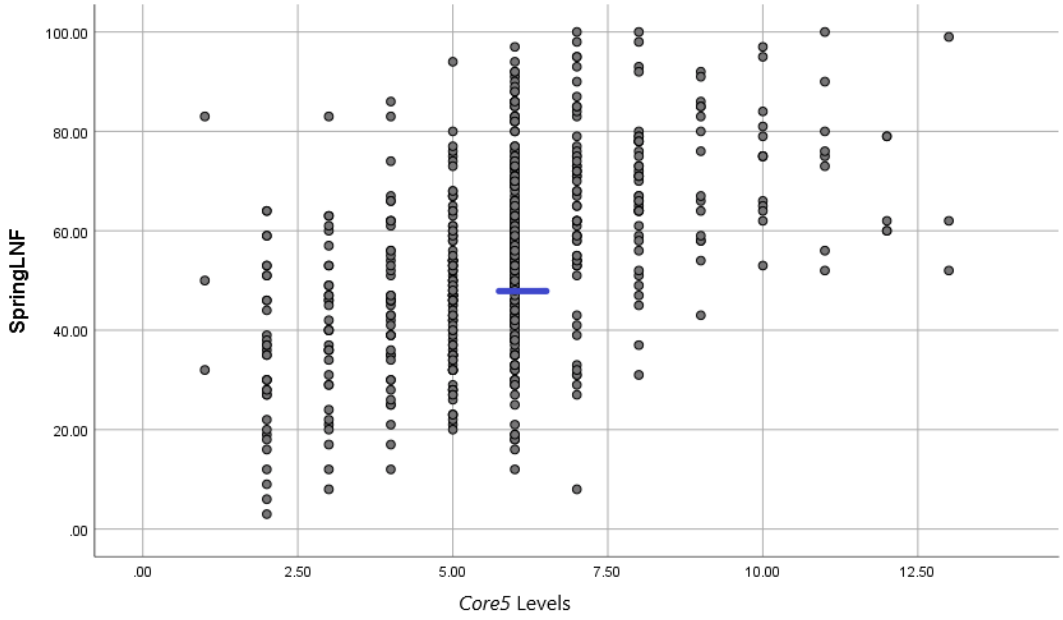


Figure 4.4: Scattergram of posttest LSF scores and *Core5* levels

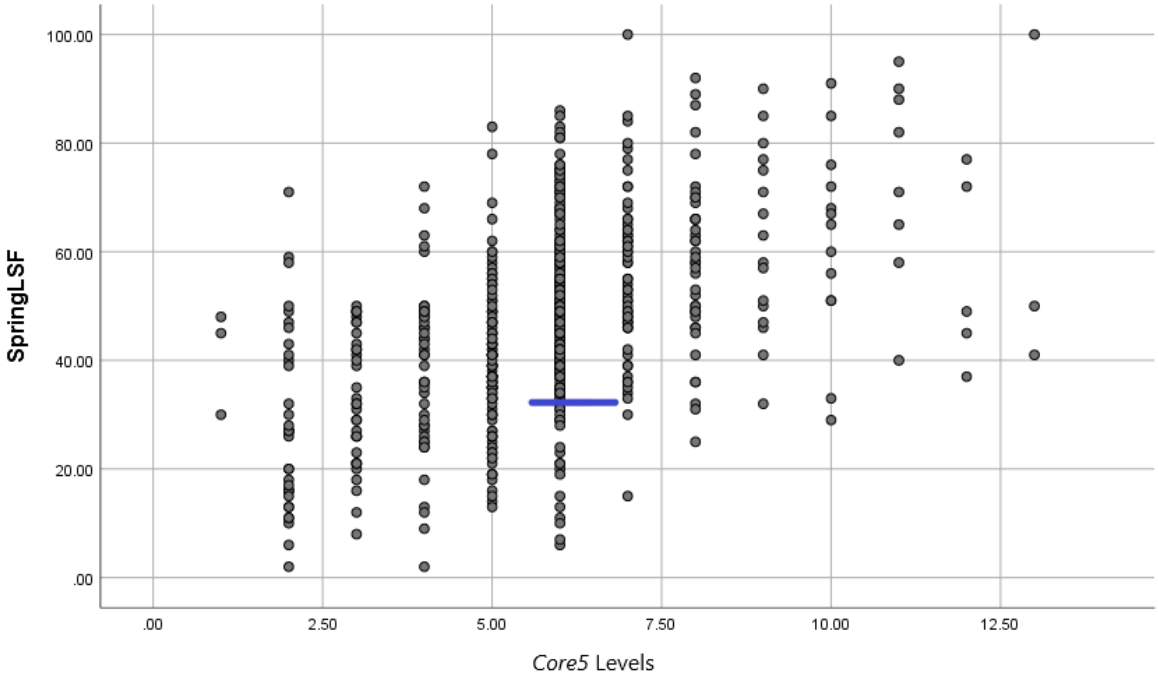
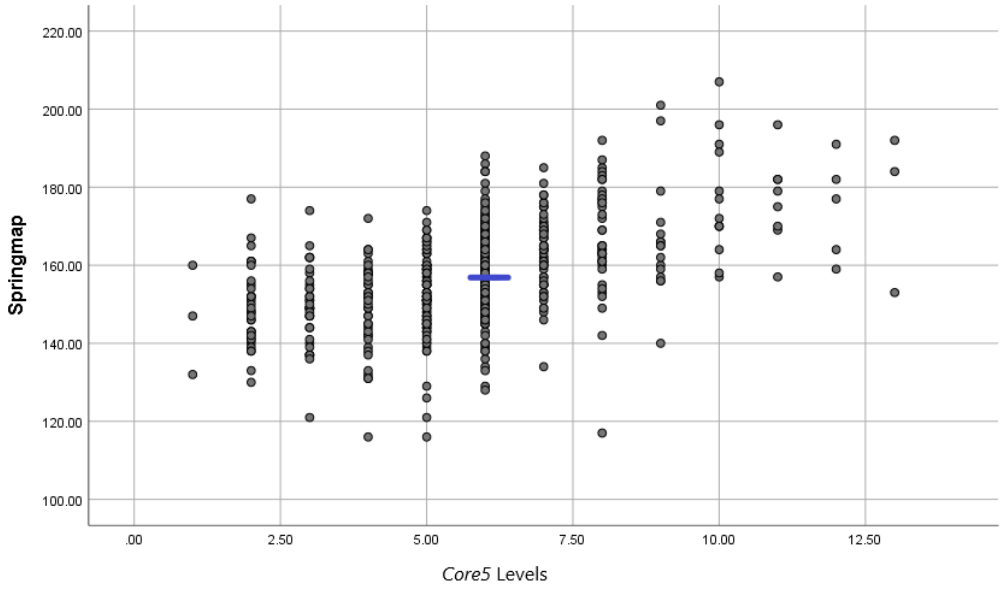


Figure 4.5: Scattergram of posttest MAP K-2 Early Literacy scores and *Core5* Levels



While a quick inspection of a scattergram can provide a quick assessment of the correlation, using Pearson's *r* provides a more precise correlation coefficient. According to Salkind (2017), if the correlation coefficient or *r* = 0.4 to 0.6, then the relationship between the two variables is moderate. Based on Table 4.16, the correlation between *Core5* levels and LNF was *r*=0.487. The correlation between LSF and *Core5* levels was slightly stronger with *r*=0.496. The strongest correlation was between *Core5* levels and MAP K-2 Early Literacy scores with *r*=0.519. Based on Salkind's (2017) interpretation of the strength of the correlation, the correlation between *Core5* levels and each probe was only moderate in this study.

In order to determine the impact of *Core5* levels on the variance in meeting benchmark scores, the coefficient of determination was calculated by squaring the correlation coefficient (*r*). Increased *Core5* levels could explain only 24%-27% of the variance in meeting benchmark scores. The variance for LNF was 0.487^2 = 0.237 or 24%. The variance for LSF was 0.496^2 = 0.246 or 25%. The variance for MAP K-2 Early Literacy was 0.519^2 = 0.269 or 27% (Table 4.17). Therefore, while

there is a moderate correlation between *Core5* levels and benchmark scores, there are other factors that affect the kindergarten benchmark scores.

Table 4.17: Pearson Correlation of *Core5* levels and Assessment Scores

Core 5 Level		*Core5* Levels	Posttest LNF	Posttest LSF	Posttest MAP
	Pearson Correlation	1	.487	.496	.519
	Sig. (2-tailed)		.000	.00	.000
	N	595	595	595	595

Table 4.18 provides a detailed look at *Core5* levels and benchmark scores. This examination of the end-of-year *Core5* levels and assessment scores indicated that 71% of kindergartners who were at *Core5* level five or six met or exceeded the benchmark scores for LNF. The percentages were even better for LSF. Approximately 85% of kindergartners who were at level five or six met or exceeded the benchmark scores for LSF. The percentages for MAP K-2 Early Literacy were 52%. It is interesting to note that a small percentage of kindergartners working at above kindergarten grade *Core5* levels still did not meet the benchmark scores on the LSF, LNF, and MAP K-2 Early Literacy assessments.

Table 4.18: *Core5* End-of-year level status and assessment alignment

***Core5* level status**	N	LNF				LSF				MAP			
		Below benchmark		Met or above benchmark		Below benchmark		Met or above benchmark		Below benchmark		Met or above benchmark	
		n	%	n	%	n	%	n	%	n	%	n	%
Below grade level 1-4	115	66	57	49	43	58	50	57	50	86	75	29	25
End-of-year level 5-6	334	97	29	237	71	51	15	283	85	160	48	174	52
Above grade level 7+	146	14	9	132	91	7	5	139	95	31	21	115	79

The third research question asked: *What is the correlation between completing all kindergarten Lexia Reading Core5® levels and meeting end-of-year benchmarks?* A quick assessment of the scattergrams suggested there was a correlation. Using Pearson's *r* to determine if a true correlation between the three posttest data and *Core5* levels existed, a moderate correlation was detected. The correlation coefficient of r=0.487 (*Core5* and LNF), r=0.*496* (*Core5* and LSF), and r=0.*519* (*Core5* and MAP) indicated a moderate correlation.

4.8 Teachers' Perceptions of *Core5*

The results of an online survey answered the last research question.

RQ4. What perceptions do teachers have regarding *Lexia Reading Core5®?*

This question investigated the perceptions teachers had on *Core5* as an early literacy intervention. The first part of the survey used a series of statements in which the participants responded by selecting a number on a five-point Likert Scale. Participants could select *one* if they strongly disagreed with the statement or *five* if they strongly agreed with the statement. If they just agreed or disagreed, then they selected *two* or *four*. If they were neutral on the statement, then they selected *three*. The second part of the survey also used statements; however, the Likert scale was a four-point system with the answers ranging from always to never. The statements on the survey addressed teachers' beliefs on *Core5's* impact on student learning, their student engagement and their ability to implement the program.

4.8.1 Teachers' beliefs on *Core5's* impact on student learning

The first statement of the survey was related to *Core5's* impact on students' scores. The statement was "I think *Core5* does not improve kindergarten early literacy skills." This question was important as teacher attitudes can influence how well an intervention is implemented (Fogarty et al., 2014). Because this question was written in the negative, if teachers thought that *Core5* did improve student test scores, then they would select strongly disagree or disagree. On this question, 75% of the teachers responded that they disagreed or strongly disagreed with the statement. However, 19%, agreed with the statement suggesting they did not think *Core5* improved student scores.

The next statement on how *Core5* influences student learning was "*Core5* closes learning gaps." The responses were again in favour of *Core5.* On this question, 80% of the respondents agreed or strongly agreed with the statement. The other respondents were neutral or did not agree with the statement.

The findings imply that overall, teachers find *Core5* to boost their kindergartner's early literacy skills. The teachers who responded to the survey had

a positive perception of how *Core5* impacted their kindergartners learning. There was a small number of teachers who did not have this opinion.

4.8.2 Teachers' Beliefs on Student Engagement with *Core5*

The next set of statements is related to teachers perceptions of how the students liked *Core5.* Student engagement is critical because research on CAI points to student engagement as a crucial aspect for a CAI programme to be successful (Kreskey & Truscott, 2016).

The first statement in this section was "My students like using *Core5."* While the majority of the respondents (75%) agreed or strongly agreed with the statement, 25% did not agree with the statement.

The next statement was similar to the first statement: "I think *Core5* is engaging for my students." The answers on to this statement were again positive, with 70% agreeing or strongly agreeing. Interestingly, 25% of the respondents were neutral on this question, and one respondent strongly disagreed.

The findings imply that teachers observed that most students were engaged and enjoyed using *Core5.* However, some teachers did not think their students were engaged in the programme. This disengagement could affect the success of students using the programme.

4.8.3 Teachers' Beliefs on Implementing *Core5*

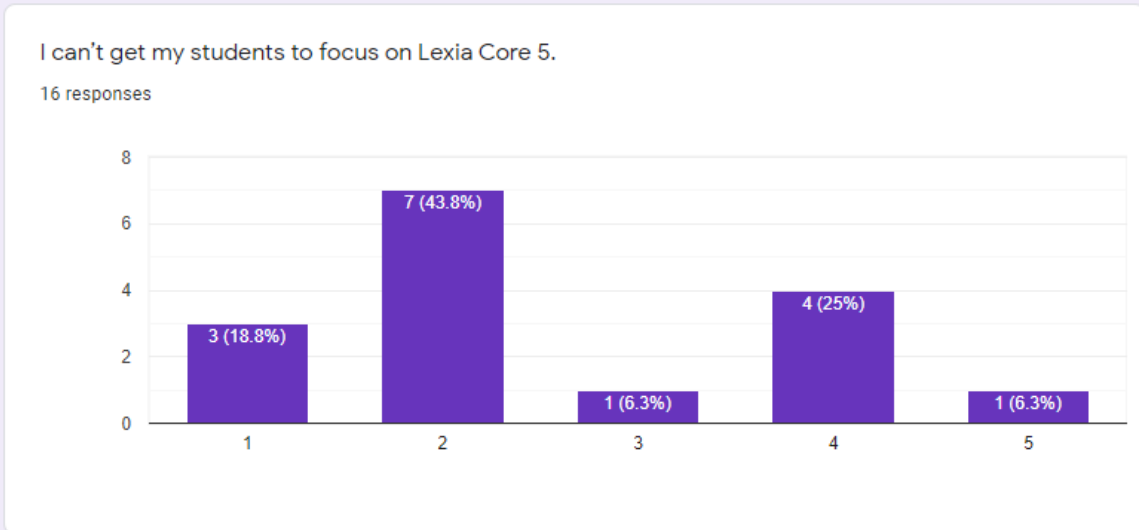
The last section of the first part of the survey focused on how teachers felt about implementing *Core5.* A quality CAI programme that is easy to use will have a higher rate of implementation fidelity (Ozen et al., 2017). A programme implemented with fidelity can be highly effective at filling in learning gaps (Ozen et al., 2017).

The first statement of this section was "*Core5* is easy to implement in the classroom." Similarly to the other statements, the responses were mostly in

agreeance (80%). Three teachers strongly disagreed or disagreed with this statement.

The second statement was “I can’t get my students to focus on Lexia *Core5.”* The responses to this statement were varied. While the majority of the respondents disagreed with the statement, 25% agreed with the statement. The results indicate that some teachers do find it hard to keep students focused on *Core5* (see Figure 4.6).

Figure 4.6: Teachers’ responses on students’ focus statement



The last statement in this section was “*Core5* takes too much work to implement in the classroom.” Again, 75% of the respondents disagreed with the statement indicating they thought it was not much work to implement.

The findings from this section indicated that the majority of the teachers did not find implementing *Core5* to be difficult or time-consuming. The findings also indicate that while most teachers found *Core5* easy to use in the classroom and easy to keep their students on track, some teachers did not find *Core5* easy to implement or use with their students.

The survey did have an open-ended question about *Core5* implementation. This allowed teachers to provide more specific reasons why they felt *Core5* was

hard to implement. Seven teachers mentioned that teaching the kindergartners to log into the computer and program was the hardest part of implementing the program.

Teacher respondent: *Logging in 21* Kindergartner*s. They take an entire year to acquire this skill.*

Teacher respondent: *Kids learning username and password.*

Teacher respondent*: The first few weeks were a challenge because I had to help each child login to their computers and show them the individual steps to get to Lexia.*

Other teachers mentioned that keeping the kindergartners engaged in the lesson was one hard part of *Core5* implementation. They felt they had to help their kindergartners through some of the levels.

Teacher respondent: *Some of the lower students would not focus and would skip from one area to another. This meant the student didn't get units completed and show progression.*

Teacher respondent: *Trying to keep the kids engaged while on. It is a major issue.*

Teacher respondent: *Often, my low students found it too challenging, especially the sight word sections. My on grade level and high students fly through levels, but my low students need one on one help to pass portions. Providing the amount of help required to get them passed portions makes me feel like they're not even learning from it.*

Lastly, some teachers mentioned other issues like technology or lack of time or absences. These issues are out of the teacher's control, but they affect how well a teacher can implement *Core5* in the classroom.

Teacher respondent: *Lack of headphones!!!!!*

Teacher respondent: *Having iPads that don't always work.*

Teacher respondent: *My biggest challenge was helping them meet those goals around student absences. Since I share a computer cart with two other classrooms, at this point, it is only feasible to have the whole class do Lexia twice*

a week (students who need more time will sometimes do it during workshop). I look forward to being able to do Lexia more regularly for shorter periods of time instead of doing it in two longer chunks of time during the week.

Teacher respondent: *Short weeks or weeks with special events like assemblies, Jump Rope for Heart and weeks like Peaks testing where the schedules were changed building-wide. Occasionally trouble with the internet or problems with Lexia.*

Based on these responses, it is clear that many teachers found teaching the kindergartners how to log into the computer and then into *Core5* was a challenging part of programme implementation. The other issues that impacted the teachers' ability to implement *Core5* effectively were out of the teachers' control. The principal is generally responsible for scheduling and providing classrooms with the technology needed to be successful. The leadership of the school places a crucial role in making sure teachers have the necessary resources to implement programmes (Stein et al., 2008).

The survey also had statements regarding implementation practices. The reason for this section was to see if the actual implementation of *Core5* in the classroom correlated to the answers on how easy or difficult *Core5* was to implement. Overall, the implementation practices mirrored the responses on the implementation statements. The percentage of teachers who indicated that *Core5* was easy to implement was similar to the percentage of teachers who practised proper implementation strategies.

In this section, the teachers selected *never*, *sometimes*, *often* or *always* in response to the statement on *Core5* implementation — three statements related to how the teacher monitored their kindergartners and encouraged engagement. Half the teachers indicated they always or often provide verbal promoting to promote student engagement, and the other half said they did that sometimes (see Figure 4.7). The majority of teachers (91%) indicated they always or often walked around the room monitoring students (see Figure 4.8).

Figure 4.7: Engagement statement and responses

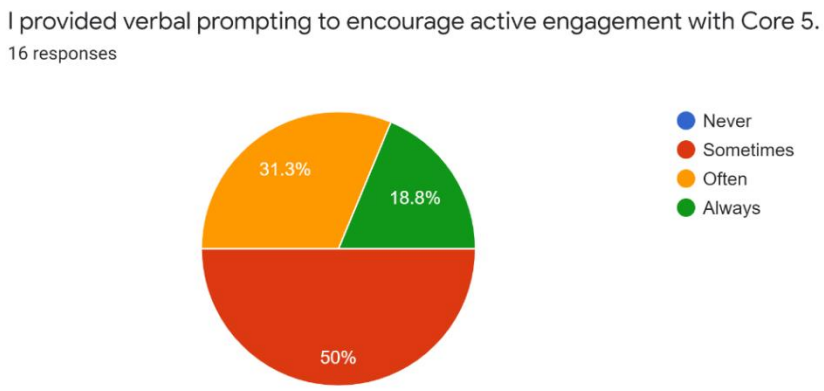
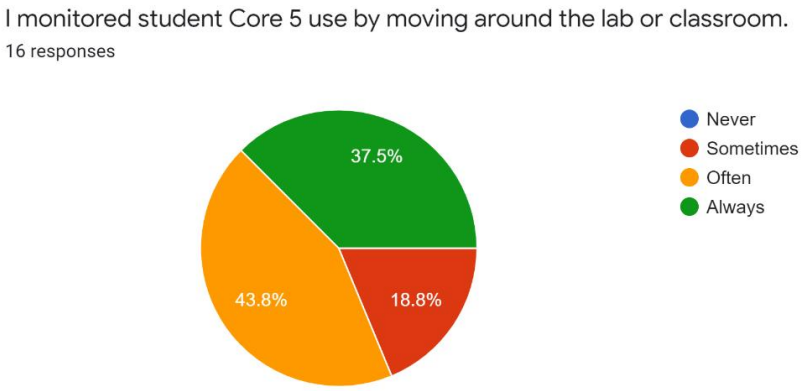


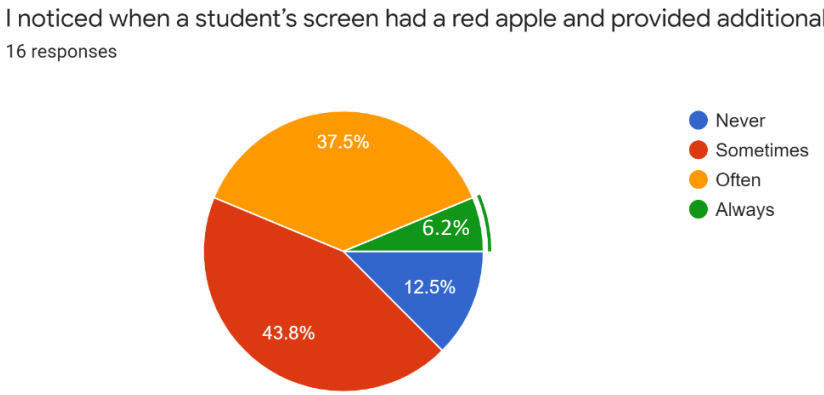
Figure 4.8: Monitoring statement and responses



The last statement is related to how teachers monitored students who needed assistance. When a student is not moving through an activity even after being retaught a skill or when a student is just not working on an activity, a red apple pops up on the corner of the screen. The red apple signals to the teacher that this child needs additional assistance or encouragement to stay engaged with the program. Interestingly, some teachers (12.5%) never noticed the red apple. On this statement, the majority of the responses fell in the sometimes and never categories (see Figure 4.9). If teachers were monitoring their kindergartners by

moving around the room, it is possible they were able to assist the struggling kindergartners before the red apple appeared.

Figure 4.9: Noticing the red apple statement and responses



The next section of statements are related to if teachers provided additional instruction to struggling kindergartners. All the teachers indicated they provided instruction, but the frequency varied with 42% of teachers providing instruction some of the time, 31% providing instruction often, and 25% providing instruction always (see Figure 4.10). The next statement asked if the teachers used the materials provided on the myLexia dashboard. Only 12.5% of teachers always used the materials, and 19% never used supplementary materials. However, 62% of teachers indicated they used the materials sometimes (see 4.11). These results indicate that the majority of the teachers at least knew where to find the materials and have used them at least once.

Figure 4.10: Providing additional instruction statement and responses

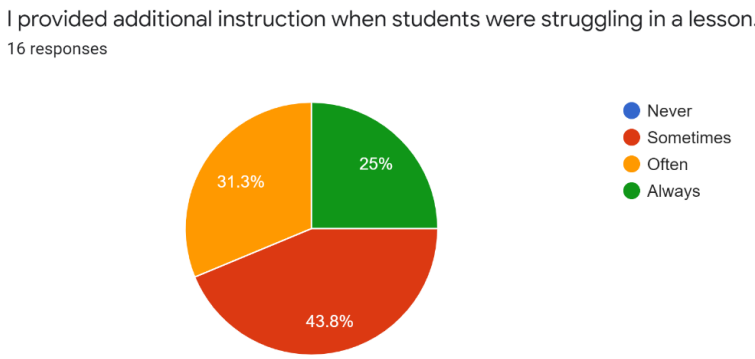
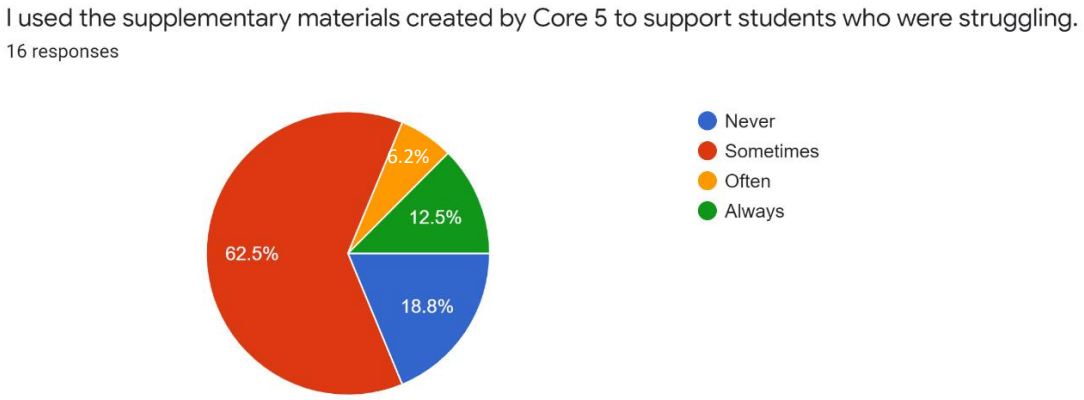


Figure 4.11: Using *Core5* supplementary materials statement and responses



Figures 4.12, 4.13 and 4.14 indicate how teachers tracked the completion of *Core5* levels and if they celebrated each level completed with awards. Most teachers (81%) indicated they always tracked student completion of levels. However, only 69% of those teachers always used myLexia to track level completion (see Figure 4.13). The responses indicate that some teachers were not consistently checking myLexia to track levels. Lastly, 69% of teachers always printed out the awards from myLexia and celebrated when a kindergartner passed

a level. The rest of the teachers indicated they sometimes celebrated and printed out awards.

Figure 4.12: Tracking student completion statement and responses

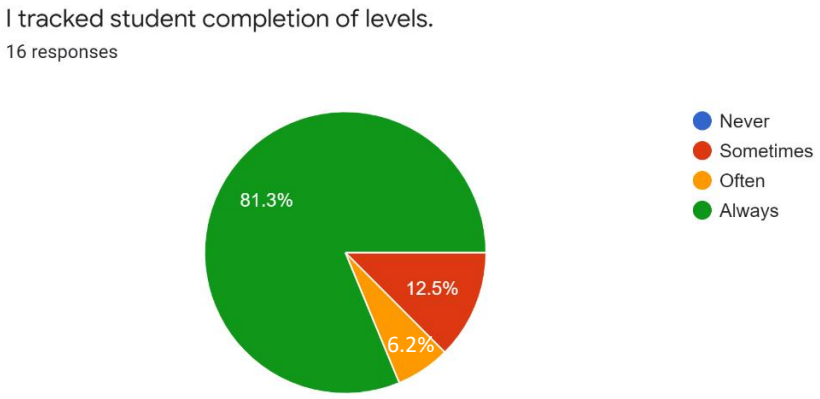


Figure 4.13: MyLexia tracking statement and responses

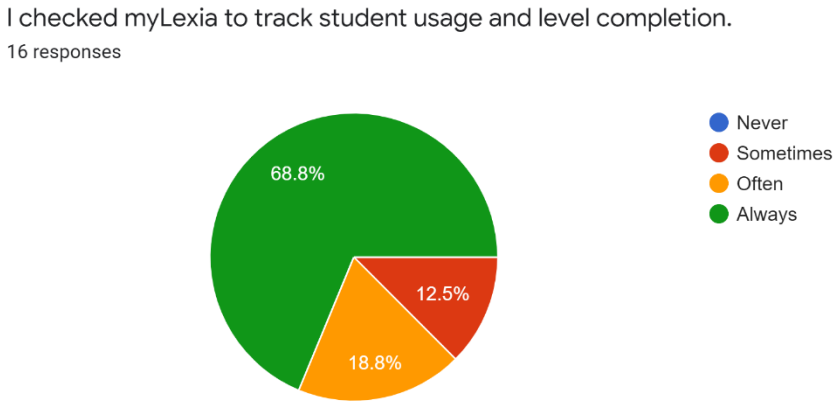
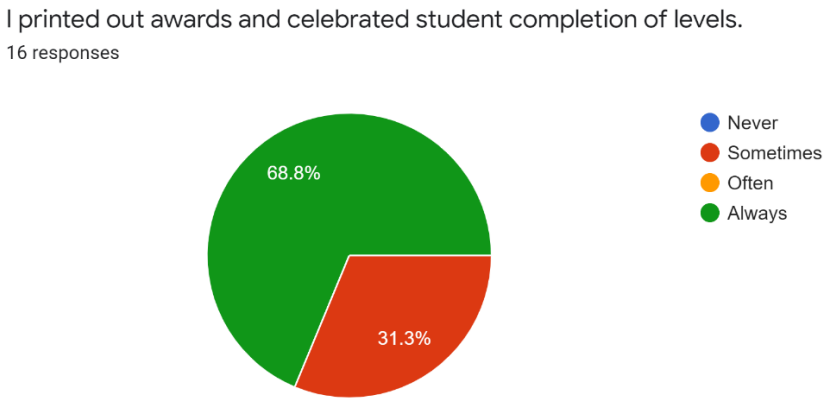


Figure 4.14: Awards and celebration of completed levels statement and responses



The final section included two statements regarding if the kindergartners met the required weekly minutes and how many times a week, the kindergartners used *Core5*. As mentioned in some of the respondents' comments on implementation, absences, and schedule changes were one reason it was hard to implement *Core5*. Thus, it is not surprising that the majority of teachers said their students often met the required minutes instead of always (See Figure 4.15). Also, since some teachers had to share a set of Chromebooks or iPads, it was not surprising to see that not all teachers got their kindergartners on *Core5* the recommended three to four times a week (see Figure 4.16).

Figure 4.15: Weekly required usage statement and responses

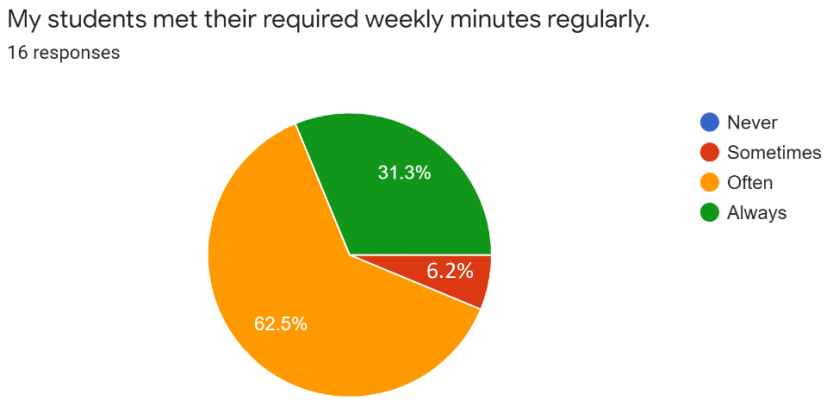
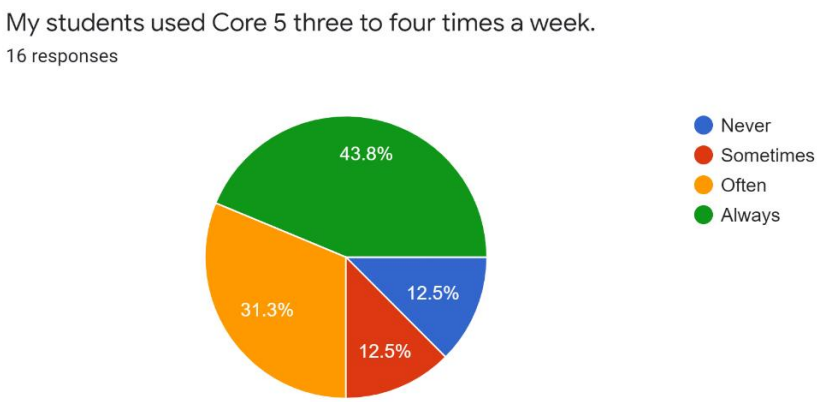


Figure 4.16: Times used during the week statement and responses

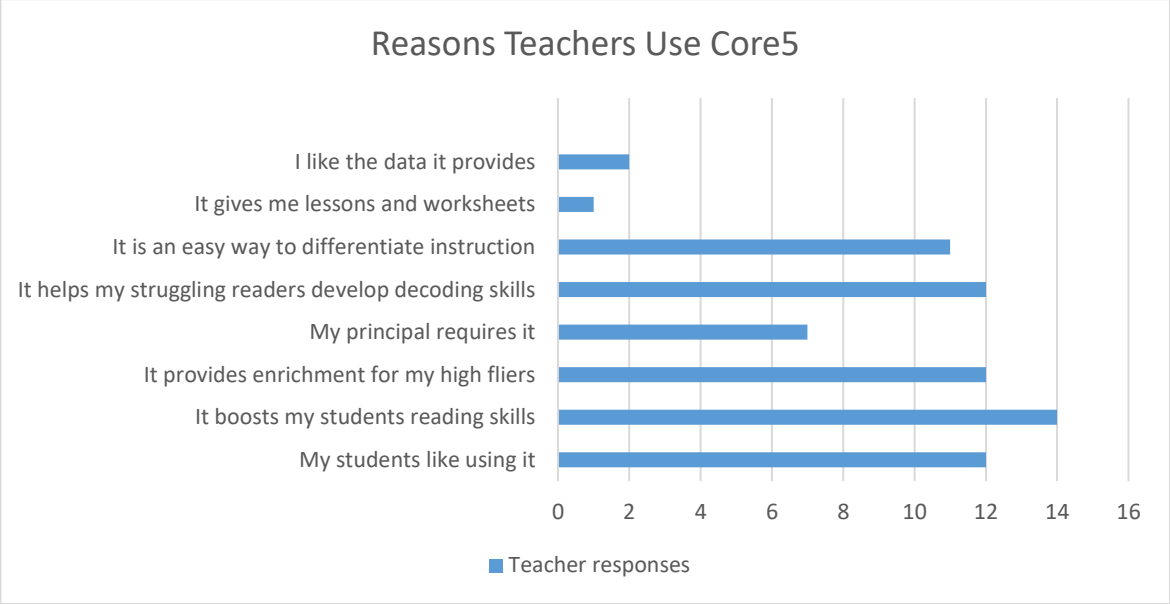


Based on the responses in this section, the majority of teachers found *Core5* easy to implement in the classroom. A majority also almost always or often followed the *Core5* guidelines for implementation such as tracking levels and monitoring usage, providing verbal encouragement, celebrating completed levels, and meeting required weekly usage.

4.8.4 Reasons Teachers use *Core5*

The next section of the survey asked teachers to select the reasons they used *Core5* in their classroom. This section provided insight regarding whether teachers used *Core5* because they thought it was useful or because they were required to use it. The teachers were allowed to select all the reasons they used *Core5* as well as adding any reasons not listed. As noted in Figure 4.17, 14 teachers selected using *Core5* because it improved reading skills, and 12 teachers also selected that *Core5* helped struggling readers improve decoding skills. A couple of teachers added that the data *Core5* provided was the reason for using it. The fact that *Core5* provided enrichment for high-fliers was an important reason for 12 teachers. Not only did many teachers using *Core5* to increase reading skills, but also 12 teachers used *Core5* because their kindergartners enjoyed using it. Overall, the reasons teachers used *Core5* in their classroom were because of the benefits of the program.

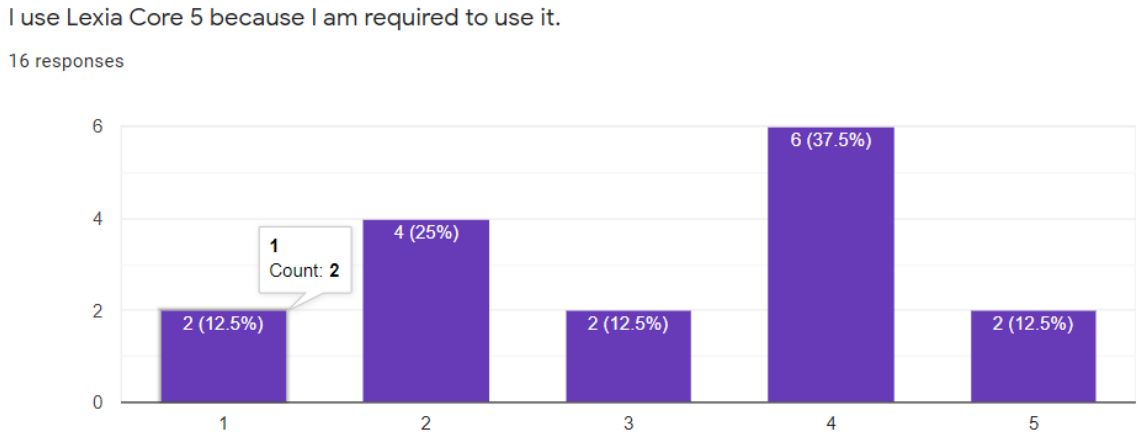
Figure 4.17: Reasons why teachers use *Core5* in the classroom



Seven teachers selected the reason they used *Core5* was that their principal required it (see Figure 4.17). However, in the statement about whether

they were required to use *Core5*, half of the participants indicated they were required to use it (see Figure 4.18). The other half indicated they were not required to use *Core5*. Thus, they chose to use *Core5* based on their perceptions of how beneficial it is.

Figure 4.18: Required to use *Core5* statement and responses



4.8.5 Teachers' Thoughts on *Core5*

The teachers were also provided with an open-ended section where they could share their thoughts on *Core5.* Most of the responses were about how the programme was outstanding, and their kindergartners loved using it.

Teacher respondent: *Lexia is a great program to use to help students in many different levels of instruction. My High kids get to continue through and the lower kids get time to understand the lessons and go at their own pace. A great teaching tool. The kids love it and get excited to get to their next level.*

Teacher respondent: *This is my first year using it consistently because I have Chromebooks. The kids love it, and some even choose to do Lexia as a centre choice during free-choice time.*

Teacher respondent: *I love using it and am in mylexia at least two times a day checking progress, minutes, struggling students, etc. We train students to let us know if a red apple shows up so we can get to it right away. I use the yellow*

warnings to make quick groups for small group instructions. I just learned how to use MyLexia well last year.

Teacher respondent: *Lexia can be over-stimulating, and they get busy watching all the picture and sounds. I find this with my kiddos with special needs and students with possible learning issues the most. Lexia Core5 can also be very repetitive and boring for kids. Some of my top readers and students just finished level 5. However, another just finished level 10.*

Teacher respondent: *I don't use Lexia lessons to provide support.*

The above comments correlate with the responses to the survey statements. Some teachers found *Core5* to be a great way to help both their low performing kindergartners and their high fliers. They also found that *Core5* provides valuable data on individual kindergartner's growth. The comments also indicated that their kindergartners enjoy using *Core5* to the point where some kindergartners even wanted to use *Core5* during their free-choice time (the time where the kindergartners play). The above comments also indicated that for some students, *Core5* is not a good choice. That sentiment was evident in the comments of teachers who sometimes felt they had to help their low preforming kindergartners complete tasks to progress through the levels, and in the comments that for some children the program was tedious or distracting.

The last research question asked: *What perceptions do teachers have regarding Lexia Reading Core5®?* Overall, the majority (75% of the kindergarten teachers had positive views of *Core5.* They believed that *Core5* improved early literacy skills and closed learning gaps. They also felt that it was easy to implement in the classroom and that their kindergartners enjoyed using it. However, 25% of the teachers either were not sure or did not believe *Core5* improved early literacy skills. They also thought *Core5* was challenging to implement in the classroom and that it was hard to keep their kindergartners engaged.

4.9 Conclusion

This chapter discussed how the data was analysed, and the results from the data answered the three research questions. The treatment group, the partial treatment group and the control group had significant improvement from pretest to posttest on all three probes. However, there was a statistically significant difference between the treatment group and the partial treatment group, and with the control group (p=0.000) on the LNF and LSF AIMSweb probes. Thus, the null hypothesis for the first research question was rejected. There was no statistically significant difference between the three groups on the MAP K-2 Early Literacy test (p=.284) and the null hypothesis for the second research question was accepted. There was a moderate correlation between end-of-year *Core5* levels and meeting benchmark scores on the three assessments. This moderate correlation could account for the variance between *Core5* levels and scores only 24-27% of the time. Lastly, teacher perceptions of *Core5* were mostly positive, with 75% believing it was an excellent programme to use in the classroom to improve early literacy skills. They thought it helped provide enrichment for their high performers and allowed their low performers to work at their own pace. About 25% of the teachers thought that it was hard for their low performing kindergartners and that it many of their kindergartners found it boring.

This chapter investigated the findings and analysis of the data collected through the three assessments and the survey. The findings then provided a platform to accept or reject the null hypotheses of the primary research questions. The findings also answered the secondary questions. In the following chapter, the implications of the data will be discussed concerning previous research, school policy, and current theories.

5 Chapter 5: Discussion

5.1 Introduction

The purpose of this study was to evaluate the impact of *Lexia Reading Core5*® on the early literacy development of kindergartners in the Matanuska Susitna Borough School District in Alaska. The purpose of this chapter is to discuss the results and how they relate to the existing literature as well as their implications of the field of study. The chapter will close with the limitations of the study and the conclusion of the chapter

Lexia Reading Core5® was the CAI programme at the focus of this study. The four questions answered in this study were:

RQ1. Is there a statistically significant difference in the decoding skills (letter name fluency and letter sound fluency) of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

RQ2. Is there a statistically significant difference in the vocabulary and comprehension skills of kindergarten students meeting the *Lexia Reading Core5*® recommended usage, kindergarten students using *Lexia Reading Core5*® less than recommended, and kindergarten students not using *Lexia Reading Core5*®?

RQ3. What is the correlation between completing all kindergarten *Lexia Reading Core5*® levels and meeting end-of-year benchmarks?

RQ4. What perceptions do teachers have regarding *Lexia Reading Core5®?*

5.2 Interpretation of the Results

RQ1. Is there a statistically significant difference in the decoding skills (letter-name fluency and letter-sound fluency) of kindergarten students meeting the Lexia Reading Core5® recommended usage, kindergarten students using Lexia

Reading Core5® less than recommended, and kindergarten students not using Lexia Reading Core5®?

The first question examined how *Core5* affected the kindergartners' decoding skills, in particular, their letter name fluency and letter sound fluency. The findings indicate that using *Core5* for even less time than recommended increased the kindergartners' letter-name fluency and letter-sound fluency. All three groups made substantial gains pretest to posttest because the kindergarten classroom instruction focuses on phonological awareness (letter sounds) and letter recognition. However, the two groups that used *Core5* gained 41-43 letter-names a minute and 41-42 letter-sounds a minute while the control group only gained 32 letter-names a minute and 34 letter-sounds a minute. The data indicated that the effect size for *Core5* was medium. The gains on the AIMSweb probes in the current study were similar to the gains in Kazakoff et al. (2017) study. The researchers found that the participants made a gain of an average of 33 letter-names a minute.

These results were similar to O'Callaghan et al.'s (2016) study of four to six-year-olds in Ireland that found the *Core5* intervention group were better at blending, and phoneme segmentation and determined the effect size of the treatment was small. The intervention and control group made substantial gains pretest to posttest, but there was a statistically significant difference between the group using *Core5* and the control group (O'Callaghan et al., 2016).

The results from the current study supporting *Core5* as an effective way to improve decoding skills were contrary to Ness et al.'s (2013) study on *Lexia Reading* (an earlier version of *Core5*) in New Zealand with primary students which indicated no statistically significant difference between the treatment and the control group. Schechter et al. (2015) cited the lack of resources and teacher support as the reason there was no statistically significant difference between the two groups. However, the data from the AIMSweb probes from the current study indicated that even the partial treatment group made gains similar to the treatment group. Thus, it would seem that even if there was limited teacher support of the

programme in the Ness et al. (2013) study, there still should have been gains if the participants used the programme correctly. It should be noted that in Ness et al. (2013) study they were using a previous *Core5* version. The different version could be the reason those results differ from the current study. Another factor could be there were a range of grades in the Ness et al. (2013), and in the current study the participants were all kindergartners.

Interventions in decoding skills and phonemic awareness need to provide repetition of the skill practised (Hudson et al., 2011). *Core5* provides practice in automaticity and fluency in letter names and letter sounds. The gains made by the treatment group and the partial treatment group indicate that the additional practice provided by *Core5* is a reason there is a statistically significant difference between the groups using *Core5* and the control group.

RQ_2 Is there a statistically significant difference in the vocabulary and comprehension skills of kindergarten students meeting the Lexia Reading Core5® recommended usage, kindergarten students using Lexia Reading Core5® less than recommended, and kindergarten students not using Lexia Reading Core5®?

The second question evaluated *Core5*'s impact on vocabulary and comprehension skills. The findings from this study did not support *Core5* as a way to improve vocabulary and comprehension skills even though *Core5's* vocabulary strand provides rich exposure to essential vocabulary words and to help the student learn different word relationships or associations, and the comprehension strand builds language comprehension through different listening activities (Lexia Learning, n.d.). The data from the MAP K-2 Early Literacy probe did not show any statistically significant difference between the three groups on comprehension and vocabulary. All groups made an average of 17-18 point gains on the RIT scale, and there was only a two-point difference between the groups who used *Core5* and the control group on the posttest. However, the treatment and partial treatment group mean on the MAP K-2 Early Literacy probe was at the benchmark

score of 158 while the control group fell short of the benchmark with a score of 156.

There is no previous research on *Core5*'s impact on vocabulary and comprehension gains with kindergartners. However, Macaruso and Rodman (2011) did investigate *Lexia Early Reading* (an early *Core5* programme) and kindergartners listening comprehension. Their results were similar to this study and showed no difference between the treatment and the control group (both groups had a posttest mean of 16.1).

On the other hand, there is previous research that found that students in first through third grade made significant gains in vocabulary and comprehension (Schechter et al., 2015). In Schechter et al.'s (2015) study on first and second-graders, the treatment group made twice the gains on the comprehension test than the control group. The gains were less with vocabulary, but there was still a statistically significant difference between the two groups. *Core5* has a moderate to large effect on English Language Learners (ELL) students' comprehension when compared to non-ELL students (Schechter et al., 2015). This difference was not examined in this study since the ELL population size was small. Baron et al. (2019) also found that the third-grade participants in this study who used *Core5* increased their comprehension skills. The students gained approximately 20 points from pretest to posttest. However, there was no control group with which to compare gains.

RQ3. *What is the correlation between completing all kindergarten Lexia Reading Core5® levels and meeting end-of-year benchmarks?*

The third research question studied the correlation between students completing *Core5* levels and meeting end-of-year benchmarks. There was a moderate correlation between completing *Core5* levels and meeting end-of-year benchmarks. Completing *Core5* levels accounts for 24-27% variance in increased scores on the benchmark AIMSweb and MAP K-2 Literacy probes.

About half of the students using *Core5* ended the year on level five or six. The rest of the students fell on either side of the end-of-year goal for *Core5* with a quarter working in first-grade material, and a quarter working on the beginning of the year kindergarten material. While there was a moderate correlation, 29% who were at the end of the year *Core5* level did not meet the benchmark scores on the LNF probe, and 15% did not meet the benchmark scores for the LSF probe. The alignment between MAP K-2 Early Literacy and *Core5* levels was the weakest, with 48% of students who were at the end-of-year *Core5* levels did not meet the MAP K-2 Early Literacy benchmark score (see Table 4.17).

The current study did not find a strong alignment between MAP K-2 Early Literacy and *Core5* level; however, Mitchell, Baron, and Macaruso (2018) found that 86% of the students (participants were from 25 schools and in grades K-5) who were at the *Core5* end-of-year levels met the benchmark score on the MAP K-2 Early Literacy test. The current study and Mitchell, Baron, and Macaruso (2018) both found a moderate correlation between *Core5* levels and benchmark scores on MAP K-2 Early Literacy.

The current study had similar results to Prescott et al. (2018), who also studied the correlation between *Core5* levels and benchmark levels, but on the GRADE probe. The participants were from kindergarten to fifth grade. The researchers found a small correlation between *Core5* levels and posttest improvement on GRADE and 26.6% of the variance on the growth on the probe GRADE was a result of either the student's grade or *Core5* levels.

Lexia Research Company (2018) published a validity report on *Core5* using Indiana assessment IREAD-3. The report found a moderate correlation of .65. The report also found that only 13% of students who were working on grade level did not pass the Indiana state standards, and only 3% of students who finished the *Core5* grade levels did not pass. These percentages were much lower than the current study and indicate that Indiana's IREAD-3 assessment is more aligned to *Core5* levels than the Matanuska Susitna Borough School District's end-of-year assessments.

RQ4. What perceptions do teachers have regarding Lexia Reading Core5®?

The fourth research question investigated the perceptions teachers had of *Core5.* The findings indicated that the majority of the teachers who participated had positive attitudes towards *Core5.* They believed that *Core5* improved early literacy skills and that it was easy to implement in the classroom. The problem many teachers had when implementing *Core5* was teaching the kindergartners how to log into the computer and navigate to the *Core5* website. Other issues included access to technology, absences and school schedules. However, some teachers did not find *Core5* to be useful. They mentioned that it was hard to keep their kindergartners engaged in the programme and that they had to spend time helping their low performing kindergartners pass each activity.

Schechter et al. (2017) state that the classroom environment created by the teacher can support or undermine the student's motivation and engagement with a blended learning programme. Thus, the perceptions teachers have of *Core5* can directly impact how the students feel about *Core5.* The researchers also point out that the teacher's motivation in using a programme is a predictor of how successful they will be at implementing that program in the classroom (Schechter et al., 2017).

While Schechter et al. (2017) did not specifically research teacher perceptions of *Core5,* they did investigate how teacher engagement with *Core5* can foster student engagement and impact learning outcomes. Teachers self-reported their use of myLexia as part of a usage contest. The researchers then compared the teachers' participation with the student performance on *Core5.* The findings indicated that the percentage of students meeting weekly minutes increased from 65% to 68% when the teachers were actively engaged in monitoring students via myLexia. The percentage of students meeting weekly minutes in classes where the teachers were not actively engaged with myLexia decreased from 53% to 52%. As a result, the students with teachers participating

in the usage contest completed more units than the students with teachers who did not participate in the contest.

The connection between the percentage of students meeting weekly minutes and teacher perceptions was not made in this study because the survey was anonymous, and the student data was not associated with specific teachers. However, based on the survey responses, the percentage of teachers who perceived *Core5* to be a valuable programme, and the percentage of teachers who reported their students met the weekly minutes regularly were similar. The findings seem to indicate that the attitudes of the teachers towards *Core5* may affect how the teachers implement it in their classroom.

In summary, the results of the current study support the research that CAI programmes are a useful intervention tool. It also supports *Core5* as an effective programme to boost decoding skills. The data also correlates with Hudson et al.'s (2011) findings that interventions in letter-sound knowledge and phonemic awareness that occur three times a week for at least 20 minutes would significantly improve children's literacy skills. Even the kindergartners who did not meet the recommended *Core5* usage benefitted from the repeated exposure.

On the other hand, the results do not support *Core5* as an intervention to improve vocabulary and comprehension skills in kindergartners. The reason could be because kindergartners learn vocabulary and comprehension skills best when being explicitly taught in the context of a text. Kindergartners might have a harder time learning those skills from *Core5* than from teacher-directed instruction which could be why there was no difference between the three groups.

Lastly, the results also indicate that a majority of teachers have a favourable view of *Core5,* which is important to the implementation of *Core5* because their attitude is a significant predictor of student use in the classroom. The teachers' attitudes affect their enthusiasm, and that enthusiasm is transferred to their students (Bii et al., 2018). Teachers' attitudes are crucial to the desired implementation of CAI programs (Ozer, 2018).

5.3 Implications of the Results

The results of this study can be used in several ways. First, the findings can influence how *Core5* is used as an intervention. The results can also inform policymaking decisions in the Matanuska Susitna Borough School District or other school districts. Lastly, the results can be used to support the *simple view of reading* theory and the Zone of Proximal Development.

5.3.1 Practice

The results from this study suggest that teachers should incorporate *Core5* as part of the kindergarten curriculum to boost decoding skills. Decoding skills are an integral part of learning to read (Savage et al., 2015) and the foundation of the kindergarten curriculum. Thus, any intervention or additional practice in decoding can help boost impoverished early literacy skills and can help kindergartners reach the benchmark goals. The results of this study indicate that *Core5* does affect kindergarten literacy skills in decoding and is an effective intervention.

On the other hand, the results of this study do not support *Core5* as an intervention to improve vocabulary and comprehension in kindergartners. Comprehension is also crucial to learning to read (Savage et al., 2015). These results are similar to the results found in previous research (Schechter et al., 2015; Baron et al., 2019). Thus, kindergarten teachers should know that if a kindergartner is struggling with vocabulary or comprehension, this programme will not help them very effectively.

Besides being effective at improving decoding skills, *Core5* is an effective blended learning programme to differentiate in the classroom. Using *Core5* allows teachers to utilise blended learning as a tool to provide enrichment as well as remediation for struggling students. The data from the*Core5* teacher dashboard enables the teacher to know what areas students struggle (Kazakoff et al., 2018). In the current study, 25% of kindergartners were able to progress through the kindergarten *Core5* levels and were in the first-grade *Core5* levels. However, it is

essential to note that even though some kindergartners progressed quickly through *Core5*, they still did not meet the end-of-year benchmark scores (see Table 4.17).

5.3.2 Policy

In the Matanuska Susitna Borough School District (MSBSD), kindergarten students are not placed in Tier 2 or Tier 3 intervention groups based on their beginning of year scores. The school district policy allows around six weeks of learning opportunities before determining if a student is falling behind grade level. Thus, it falls on the teacher to ensure the students are getting the support they need.

The MSBSD could implement *Core5* as a required part of the kindergarten curriculum across all schools to provide more learning opportunities. As DuBois, Volpe, and Hemphill (2014) pointed out, interventions need to be user-friendly and effective, and *Core5* fits that requirement. Since this intervention can be run smoothly in the classroom for the entire class, it saves money on having to hire interventionists to teach small group interventions.

If MSBSD did decide to implement *Core5* as part of the kindergarten curriculum, they would need to ensure that every school had the necessary technology. It would also be beneficial for teachers to be guided on how to use myLexia dashboard as well as different techniques on how to implement *Core5* in the classroom. The guidance could include how to log-in kindergartners quickly, how to keep them engaged, and how to use different blended learning models.

It is also crucial for MSBSD to note that *Core5* may not be an appropriate intervention for kindergartners who struggle with attention or kindergartners who are significantly behind. Several teachers mentioned having to help the children who had learning disabilities complete activities and stay focused. Thus, it would seem that *Core5 is* maybe less beneficial as a Tier 3 intervention than a Tier 1 or 2 programme.

5.3.3 Theory

The *simple view of reading* theory states that reading comprehension is the product of oral comprehension and decoding skills (Gough & Tunmer, 1986; Savage et al., 2015). The theory supports the results from this study. The results from this study indicate that even if an intervention is effective at decoding and fluency, it does not boost comprehension scores. Oral comprehension includes vocabulary and background knowledge. *Core5* did not significantly improve these areas but did significantly improve decoding skills. Reading interventions (like *Core5*) usually focus on decoding and fluency practice (Lim & Oei, 2015), but early literacy interventions should strive to support both strands of the simple view of reading theory: decoding and oral comprehension. Such an intervention would lay the foundation for successful readers.

The concepts of blended learning and allowing students to move through activities at their own pace and at their skill level builds on the Zone of Proximal Development concept which states "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). The findings of this study indicated that progress through the levels of *Core5* follows the concepts of ZPD. The programme provides instruction when a student has trouble completing a task. The teacher can also provide additional instruction to assist the student. Students can progress at their own pace, as seen in Table 4.17. A larger number of kindergartners were working on first-grade material while a small number were still working at the beginning of the year kindergarten material.

5.3.4 Recommendations for *Core5*

Lexia Learning Systems has used research to improve its products. *Core5* is the latest version and improves on the previous versions with a better dashboard for teachers to monitor students' progress and with supplemental materials. Based on the findings of this study, some modifications could make the product more effective. First, the vocabulary section needs to be more robust with the vocabulary taught in the context of stories. Some of the vocabulary words taught are straightforward, such as the colours, or words like *bat*. This vocabulary is suitable for ELL students or students coming from low linguistic homes but probably not as helpful for the rest of the kindergarten population. Second, the comprehension section should also be strengthened by including more oral comprehension activities such as listening to short stories and answering questions based on the story.

5.4 Originality

The originality of a study refers to the development of a study that may be original in design, thought, implications, and data. Originality may be studying a new topic or producing new findings (Clarke & Lunt, 2014). In this study, the originality is in studying a researched topic with new questions in a new location which contributed to new data. The previous research did not look at using *Core5* in Alaska, nor did it compare end-of-year levels with both AIMSweb and MAP K-2 Early Literacy benchmark scores. Also, there was no research on teachers' perceptions of *Core5* as part of a kindergarten classroom.

5.5 Limitations of the Study

As with most research, this study had several limitations. The first limitation was a result of the design of this study. This study was not a true experiment with the researcher providing instructions on how to implement *Core5* in the classroom

and with randomly assigned participants. Instead, this study examined the real-world data provided by the Matanuska Susitna Borough School District.

The second limitation of convenience sampling was based on the study's design. The students were assigned to the treatment group, partial treatment group, and control group based on their *Core5* usage. It would have been impossible to use random sampling, as many schools had already incorporated *Core5* into their kindergarten curriculum. Also, the groups were not of equal size, which was partially due to more schools using *Core5* than those that did not, and several schools not using the same assessments as the rest of the school district.

The third limitation was that the study was conducted in a single school district. The population of the school district does have a similar low socioeconomic status, and the majority of the students were of the same ethnic background. Consequently, the external validity of the findings could be questioned, and the findings might be different with a more diverse population. Also, it was not possible to look at the impact *Core5* had on ELL students, migrant students or other types of populations because the numbers were too small.

The fourth limitation of this study was the small number of teachers who completed the survey. Only 16 kindergarten teachers completed the survey. While there was internal consistency among the answers in the survey, a larger sample size would provide more accurate values and a smaller margin of error. The external validity of the data would be stronger as well.

The fifth limitation of this study was that the survey was administered at the end of the treatment period. Because the questionnaire was not completed at the beginning of the treatment period as pretest with a posttest questionnaire at the end of the treatment period, the data did not show if the teachers had any change in their perceptions. Teachers might have been sceptical of *Core5*'s effectiveness at the beginning of the treatment period and then change their perceptions throughout the treatment period. Alternatively, they might have been excited to use *Core5*, but after having issues with implementing the program, they might not view it as favourably.

Finally, the use of the pretest-posttest design limited the observation on the differences in the three groups to a single point. A longitudinal study would provide more information on how *Core5* affects kindergartners as they begin first grade, and if the gains made during kindergarten were sustained. When studying blending learning or CAI programmes, longitudinal studies are usually for the duration of the programme use, and then they examine if there are any residual benefits after a certain period (Hurwitz, 2018). Due to the transient population of the Matanuska Susitna Borough School District, it would have been difficult to track the kindergartners into first grade.

5.6 Recommendations for Further Research

Several areas for future research could add to the findings of this study and to the work of using CAI programmes or blended learning as an early literacy intervention. The first area is comparing different CAI programmes since this study only examined *Core5*. Another study could compare *Core5* with *Starfall*, *MobyMax*, or any other computer-based reading intervention programme. It would be insightful to see if students using other programmes performed similarly. This research could also provide evidence for what programme supports vocabulary and comprehension the most effectively. Alternatively, the research might add to the evidence that vocabulary and comprehension are not supported well by early literacy interventions.

While there have been some longitudinal studies on *Core5*, they were conducted by Lexia Learning Systems researchers. Further independent research could examine if the gains made in kindergarten impacted reading skills in first grade or higher grades. The results from such a study would demonstrate if the gains made using *Core5* in kindergarten strengthened reading skills in future grades.

One limitation of this study was the relatively homogenous population. Further research that would add to this study's findings would be to use a more

diverse population. The findings from a study with a more diverse population would be able to extend the generalised findings to other student populations. Additionally, the gains made between different sub-populations could provide insight into what type of population benefits the most from *Core5* usage.

As many classes are integrating blended learning into their curriculum, further research could compare the different ways *Core5* could be implemented as part of blended learning to determine the most effective way to use *Core5*. The findings from a study looking at the differences of using *Core5* as part of a rotation or flipped style classroom could further the research on more effective ways to incorporate blended learning.

Lastly, further research could be done on the role of the teacher. Further research could examine the role teacher attitudes play on how *Core5* was implemented and what success the students had in completing the *Core5* grade levels. This information would help understand why some teachers might be hesitant to use blended learning in the classroom, and if the teachers' attitudes affected the students' growth. Further research could also conduct a pre-posttest survey to determine if teachers' perceptions of *Core5* changed after using it in the classroom. The findings would be informative to see how the perceptions of new teachers using *Core5* changed throughout using it in the classroom. This data could then be compared to teachers who have been using *Core5* in their classroom for a while.

5.7 Conclusion

Technology is becoming an integral part of the classroom. As schools move toward blended learning and using CAI programmes as interventions, schools must use programmes that have consistent evidence of effectiveness rather than programmes that are cheap or look appealing. Programmes need to be both educational and engaging for the students as well as easy for the teacher to use and implement.

This study aimed to evaluate *Core5* on kindergarten early literacy skills in the Matanuska Susitna Borough School District in Alaska. This study sought to address the problem of school-based interventions being used in the absence of sufficient and independent evidence of effectiveness (Snowling & Humle, 2011). While previous research on *Core5* indicated it was an effective CAI programme, the majority of previous studies on *Core5* were funded by Lexia Learning Systems Company. Thus, this study sought to be an independent study on *Core5* and its effectiveness.

Despite some research design limitations, the data from the study is consistent with previous studies on CAI programmes. The conclusions from this study can be reliable in that *Core5* does improve decoding skills but did not significantly boost reading comprehension skills. It also showed a moderate correlation between the end of *Core5* kindergarten levels and the end of school year MSBSD benchmark scores. The evidence from the study can inform the school district and influence any decisions they might make on using *Core5* as a regular component of the kindergarten classroom.

This study adds to the work on CAI programmes and could be used to inform state and local decision-makers on implementing technology in the classrooms. Any CAI product must be effective through independent research. Children at the most risk of failing to read require additional instructional time and practice to not fall behind their peers. CAI programmes should not be a replacement for direct instruction, but as a supplemental intervention for students to practice the skills they need to become readers.

Resources

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6 Appendices

6.1 Appendix 1: Ethical Clearance Approval, UNISA

UNISA university of south africa

ENGLISH STUDIES DEPARTMENTAL RESEARCH ETHICS REVIEW COMMITTEE

Date: 15 May 2019

Ref #: **2019_CHS_61607118_DEPT**
Name of applicant: **MS. JOY OWENS**
Student #: **61607118**

Dear Ms Joy Owens,

Decision:
APPROVED for period May 2019 to 30 May 2021

Name: MS. JOY OWENS
English Studies Department
UNISA
+1 907 306 7444
61607118@mylife.unisa.ac.za

Proposal: Addressing literacy skills in kindergartners in Alaska: An evaluation of Lexia Core 5

Qualification: Research for Degree Purposes: PhD in English

Thank you for the application for research ethics clearance by the *English Studies Departmental* Research Ethics Review Committee for the above mentioned research. **Final approval is granted for the period May *2019- 30 May 2021***

For full approval: This low-risk application was reviewed and expedited by the Chair of the English Studies Research Committee in compliance with the Unisa Policy on Research Ethics by the English Studies Departmental Research Ethics Review Committee on **15 May 2019**.

The proposed research may now commence with the proviso that:

1) *The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*

2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Department of English Studies.*

3) *The researcher(s) will conduct the study according to the methods and procedures set out in the approved application*

3) *The researcher(s) will conduct the study according to the methods and procedures set out in the approved application*

4) *Changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data should be reported to the Committee in writing accompanied by a progress report.*

5) *The research will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines, and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important if applicable: The Protection of Personal Information Act. No. 4 of 2013, Children's Act. No.38 of 2005 and the National Health Act. No.61 of 2003.*

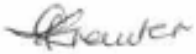
6) ***Only de-identified research data may be used for secondary research purposes in future on the condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.***

7) *No fieldwork activities may continue after the expiry date* ***(30 May 2021).*** *Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.*

Note:

The reference number **2019_CHS_55752233_DEPT** *should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the ESDRERC.*

Kind regards,

Signature 

Title & Name of the chairperson

PROF A.D. KREUITER

Add contact details

Prof Allyson Kreuiter

Department of English Studies

TvW, Floor 7, Room 07-38

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kreuiad@unisa.ac.za

6.2 Appendix 2: Matanuska School District Approval

02/13/2018

To Whom It May Concern:

Joy Owens was granted permission to complete her doctoral research project in the Mat-Su Borough School District using non-identifiable Lexia data. Her research project was also approved by her supervisor.

Sincerely,
Traci Pedersen
Executive Director of Instruction

6.3 Appendix 3: Teacher Survey

Core5 Teacher Survey

Please answer the following questions honestly. Your answers are anonymous. Thank you for your help!

1. **I think Lexia Core 5 doesn't improve student scores.**
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

2. **Lexia Core 5 takes too much work to use in the classroom.**
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

3. **Lexia Core 5 is easy to implement in the classroom.**
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

4. **Select the reasons you use Lexia Core 5.**
Check all that apply.

- ☐ My students like using it
- ☐ It boosts my students reading skills
- ☐ It provides enrichment for my high fliers
- ☐ My principal requires it
- ☐ It helps my struggling readers develop better decoding skills
- ☐ It's an easy way to differentiate instruction
- ☐ Other: _____

5. **I can't get my students to focus on Lexia Core 5.**
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

6. **My students like using Lexia Core 5.**
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

7. **I use Lexia Core 5 because I am required to use it.**
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

8. **Lexia Core 5 closes learning gaps.**
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

9. **I think Lexia Core 5 is engaging for my students.**
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

Lexia Implementation

10. **What was your biggest struggle with implementing Lexia Core 5 in the classroom?**

_____

_____

_____

_____

_____

11. **I provided verbal prompting to encourage active engagement with Core 5.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

12. **I monitored student Core 5 use by moving around the lab or classroom.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

13. **I tracked student completion of levels.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

14. **I printed out awards and celebrated student completion of levels.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

15. **I provided additional instruction when students were struggling in a lesson.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

16. **I used the supplementary materials created by Core 5 to support students who were struggling.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

17. **I checked myLexia to track student usage and level completion.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

18. **I noticed when a student's screen had a red apple and provided additional instruction.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

19. **My students met their required weekly minutes regularly.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

20. **My students used Core 5 three to four times a week.**
Mark only one oval.

- ◯ Never
- ◯ Sometimes
- ◯ Often
- ◯ Always

21. **How long have you been teaching?**
Mark only one oval.

- ◯ 0-5 years
- ◯ 6-10 years
- ◯ 11+ years

22. **Any other comments, suggestions, or thoughts on Lexia use in your classroom?**

_____

_____

_____

_____

_____